The Chemical Age

A Weekly Journal Devoted to Industrial and Engineering Chemistry

VOL. XXII. No. 574 JUNE 28, 1930 Prepaid Annual Subscription: United Kingdom, £1.1.0; Abroad, £1.5.0

Contents

PAGE

EDITORIAL: The Solvents Industry: Medical Patents: The Brotherton Library: Industry's Debt to Advertising: "Six Hours" 591
Unemployment and Work. IX: Sir Ernest Benn 593
A General Survey of the Solvents Industry: Rex Furness.. 594
Solvents, Their Manufacture and Uses: Major Denis J. Burke 597
Design and Operation of Solvent Extraction Plants: James MacGregor 598
Kestner Plant for Solvents 602
Modern Practice in Heavy Chemical Manufacture 604
By-Product Ammonia—An Economic Aspect, II: P. Parrish 608
From Week to Week 611
Patent Literature 612
Weekly Chemical Prices and Market Reports 615
Company News 622
Commercial Intelligence 624

NOTICES:—All communications relating to editorial matter should be addressed to the Editor, who will be pleased to consider articles or contributions dealing with modern chemical developments or suggestions bearing upon the advancement of the chemical industry in this country. Communications relating to advertisements or general matters should be addressed to the Manager.

The prepaid subscription to THE CHEMICAL AGE *is 21s. per annum for the United Kingdom, and 26s. abroad. Cheques, Money Orders, and Postal Orders should be made payable to Benn Brothers, Ltd.*

Benn Brothers, Ltd., proprietors of THE CHEMICAL AGE, *have for some years past adopted the five-day week, and the editorial and general offices (Bouverie House, 154, Fleet Street, London, E.C.4), are closed on Saturdays.*

Telegrams: "Allangas, Fleet, London." **Telephone: City 0244**

The Solvents Industry

THE matter published this week is a reminder of the important part that the solvents industry plays in relation to other industries, of the variety and complexity of its character, and of the business it has provided for the chemical engineer and plant manufacturer. While Mr. Rex Furness, in his introductory article, supplies a general survey of the subject, Major Burke, in his account of the works and processes of the Commercial Solvents Corporation, tells a more specific story of great industrial and scientific interest. Complex as the ultimate products of the Corporation are, the raw materials are of the simplest character—corn, coal and water—and the stages from raw material to marketable product illustrate the amazing achievements of industrial chemistry. Another notable point is that the end product in the case of the solvents manufacturer is the starting point of a whole range of other industries, of which cellulose lacquer is one of the most striking. Beyond this, yet another industry has been developed owing to the demand upon the chemical engineer for means of effecting solvent extraction or solvent recovery. All these advances are due almost directly to two great factors—the pure research of the chemist into the chemistry of the subject and the resources of the engineer in converting the reactions of the laboratory into large scale commercial practice. Though a very large quantity of solvent agents continue to be imported, it is satisfactory to find the manufacture increasing at home. This process promises to continue, and though, owing to the great industrial demands, the point must be distant when home production will equal home consumption, it is satisfactory to note that the movement is all in this direction.

Medical Patents

THE controversy as to medical patents goes merrily on—the doctors exclaiming at the sordidness of patenting anything concerned with the welfare of mankind, and the research chemists retorting that the scientific labourer is worthy of his hire, and that even eminent physicians and surgeons have been known occasionally to accept fees for saving life or repairing damage. The position taken up by the Joint Chemical Committee that recently prepared a memorandum on the subject has incidentally been criticised, but the Committee, if challenged, would probably reply that some of the letters take an incomplete and even incorrect view of the whole position; that they neglect the medical side of the question and the relationship that must necessarily exist between the chemist and the medical man in the discovery and development of new drugs and medicines; that little or no attempt is being made to deal with the present state of affairs, which is unsatisfactory in every respect and has led to a position in which this country is being outstripped in the production and manufacture of medicinal products. The memorandum itself has not been fully studied by all; it is a fairly long document, too long to be reprinted at the moment, but we hope to reproduce it in an early issue and appeal for a careful reading.

It may be noticed that the Joint Chemical Committee have issued no reply. This, if deliberate, seems to us the wise and proper policy. The Committee could not well enter into the turmoil of newspaper controversy, any more than the Cabinet could intervene in political discussion. The subject, moreover, is so large and complicated that the whole case could hardly be stated in a letter. In addition, it would probably be the feeling of the Committee that having given evidence before the Board of Trade Patents Committee, in company with other bodies, on the

subject of medical patents, the better course is to await the publication of the whole of the evidence before attempting to add any explanation to the original memorandum.

The Brotherton Library

IT was a deserved tribute to Lord Brotherton that the King paid on Wednesday, at the laying of the foundation stone of the new library of Leeds University, when he referred to his noble generosity in giving £100,000 towards the cost, and to the indebtedness of the university to him "for this welcome addition to its buildings." Nor was there exaggeration in the prophecy of the Duke of Devonshire (the Chancellor) that the Brotherton Library, when its shelves are filled, will be "one of the great libraries of the world, one of the treasures of Yorkshire, a source of legitimate pride to the University of Leeds." Lord Brotherton's generosity does not end with his gift of £100,000, following, as it does, on many others. He is making a more intimate and personal contribution in handing over his own magnificent collection of books to be held in perpetual trust for the nation. His desire, he said, was that access to the books should be accorded to all properly accredited persons, and with that end in view he was taking steps to endow the collection. It is, as some of the speakers suggested, difficult to decide which is the predominant consideration in such circumstances—the satisfaction with which Lord Brotherton must contemplate this noble memorial to his own interest in science and education or the public appreciation of so fine an example to great industrialists. The best wish that one can offer is that the donor may be spared to see for many years this "metropolitan temple of knowledge" serving the high purposes it is designed for.

Industry's Debt to Advertising

SIR ERNEST BENN'S clever and arresting sayings at the Hastings Advertising Convention are really axioms—so true are they found to be when thoroughly explored. But even axiomatic truths may be so obscured and overlain by convention that it needs very picturesque and forcible restatement to make people realise them. This Sir Ernest did with effect, and did it appropriately at a moment of national pessimism. As he put it, it does, indeed, seem that the title "The Development of Trade and Industry Through Advertising" amounts to tautology, for advertising, which is the bringing of what the maker produces to the consumer who needs the product, is the most essential stage of business. A less daring thinker might be deterred from suggesting, to take the field of electricity as an example, that the work of Sir Hugo Hirst is worthy to be ranked with that of Faraday, but at least none can be afraid of declaring that the man who brings the article or the service to the people who want it is the essential complement to the man who first invents or produces. On the Marxian slogan that "wealth is labour applied to land," Sir Ernest Benn's comment was—if this be true, "then music is catgut and horsehair, and literature is paper and ink." This sentence, in a solvents issue, may be commended as a particularly effective solvent of at least one popular fallacy.

We imagine that Sir Ernest Benn's plea for the small man or the small firm will make a wide appeal in the chemical industry, which has provided the most impressive example of rationalisation in the Empire. Rationalisation, like other things, may be expected to have the defects of its qualities; the point is whether it always retains the qualities of its defects. As time goes on, it may be found that the small concern, with its individual attention to the business and the needs of customers and its economical administration, has still a valuable place to fill in industrial and commercial life. Here, it seems to us, advertising is of vital importance. It gives the small man the chance of letting the industry know of his existence and of the personal services he is able to offer. Wisely utilised, it is the one instrument above all others that can make individual effort and enterprise still successful.

"Six Hours"

SIX hours of the time of the House of Commons was devoted the other night to the discussion of two points, first, the exemption from income tax of the salaries of consuls, and secondly, the wisdom or otherwise of deducting tax from "grants in aid of revenue-producing schemes made to local authorities." Six hours of Parliamentary time! although it is often impossible to get five minutes of Parliamentary time to discuss the affairs of the business taxpayer. This sort of thing helps to explain the irritation and contempt of the business man for the politician. It would not matter if Parliament were merely discussing an academic point with no practical substance. But when we remember that out of these six hours' discussion will arise innumerable new appointments for expensive officials with statistical training, who will argue among themselves which column in the public accounts is to be used for a given purpose, and that all this totally unnecessary expense will add to the burden of the miserable taxpayer and still further delay, both of public and private work wherever it is attempted, a little irritation seems to be justified.

Books Received

QUALITATIVE ANALYSIS. By William Briggs and R. W. Stewart. Revised by D. R. Snellgrove. London: W. B. Clive, University Tutorial Press, Ltd. Pp. 172. 4s.

THE REACTIVITY OF COKE. 3.—The Influence of Iron Compounds. Fuel Research Technical Paper, No. 25. Pp. 42. 9d.

ESSENCES NATURELLES ET PARFUMS. By Raymond Delange. Paris: Armand Colin. Pp. 222. 12 fr.

F.B.I. REGISTER OF BRITISH MANUFACTURERS. 1930-31. London: Federation of British Industries. Pp. 492.

The Calendar

June 20 to July 3	Ideal Holidays Exhibition. 11 a.m. to 9 p.m.	Royal Agricultural Hall, London.
1	W. and T. Avery, Ltd.: Bi-Centenary Luncheon. 1.15 p.m.	Soho Foundry, Birmingham.
10	Association of British Chemical Manufacturers: Annual Dinner. 7.15 p.m.	Grosvenor House Hotel, Park Lane, London.
14–19	Society of Chemical Industry: Annual Meeting. Presidental Address—Dr. Levinstein: "Only an Apprentice in Nature's Workshop."	Birmingham
Sep. 3–10	British Association for the Advancement of Science	Bristol.

Unemployment and Work

By Sir Ernest J. P. Benn

Our vast housing needs and the opportunities of employment that they should provide are considered by Sir Ernest Benn in the article below. Previous articles in this series have appeared in THE CHEMICAL AGE *of May 3, 10, 17, 24, 31, June 7, 14 and 21, and the last, on "Service the Solution," will be published next week.*

IX—Housing, the Key

IF any one thing can be singled out as the essential basis of civilised life it is surely a house to live in. Everything follows on that. Most of our trades can be regarded as subsidiaries to the house building business; if that is active, others follow on, if no houses are built, others have nothing to do. All trades are, of course, to some extent dependent on other trades; the Post Office could not exist without a paper-making industry; spoons and forks would find no sale in a market where plates and cups were absent; but a house is in a category by itself and promotes and encourages and, indeed, demands the work of almost every other trade. You cannot even have your photograph taken until you have a house with sufficient room to keep it in, while the sale of pianos almost depends upon a collection of family photographs, suitably framed and requiring a worthy pedestal on which to stand.

People Wrongly Employed

The satisfactory arrangement of the employment question involves much more than merely finding jobs for those who are at the moment out of work. There is the much bigger problem of all the employed who are wrongly or inadequately or unsuitably employed. Every one of these people, by failing to fill his or her natural place in the complicated scheme of things, is causing some little bit of trouble and hindering progress. It is impossible to know how many of us are working at uncongenial tasks and thus wasting such natural abilities as we possess, because we happen to live in a particular place and we see no prospect of getting out of it. All the experts agree as to the importance of mobility to good and satisfactory employment. If things were right, a man or a woman with labour power to sell should be able to take it where it is most wanted, but how many workers to-day have any choice whatever in the matter?

There are many trades where a variety of experience is essential to proficiency. The newspaper reporter is a good illustration. These men do, in fact, move about, they simply have to, but the moving is a troublesome, indeed, a heartrending, business. If it were not absolutely imperative it would not be done. The method is almost uniform. The man, the breadwinner, moves on and leaves his family behind. He goes into lodgings and spends much time which he can ill afford searching for permission to rent some sort of premises to which he can bring his wife and children, and then a few years later he goes over it all again. There are many thousands of people in many trades in this absurd position. If a man wants to stand as a Parliamentary candidate, he has the choice of 615 constituencies in which to work, but if he desires to serve his fellow-creatures in some humbler capacity he must do it in the district where his mother happens to have half a bedroom she can spare for his use.

A Sheltered Industry

We have pampered the housing trade into a position where it is able to avoid many of the obligations which press so heavily upon every other sort of occupation. The makers of clothes, furniture, books, cars, bicycles and, indeed, everything else, are obliged to produce their commodities, put them into stock, display them in the market, and wait the convenience and the pleasure of the buyers. But not so with houses. The fortunate persons who have chosen to adopt the making of houses as a livelihood are able to force the rest of us into the attitude of supplicants, waiting upon their pleasure, and this, as I have said, is the central cause of all our economic ills. The reason is not far to seek. Indeed, there are two main reasons, the first natural and unavoidable, the second unnatural and crying out for alteration. The former consists in the fact that housing is a sheltered industry, there is no export or import of houses, and the trade is therefore almost free from the health-giving effects of anything which can be recognised as competition. We have been foolish enough, in the second place, to intensify this natural monopoly by allowing public authorities to drive everybody else out of the housing market. There will be no real improvement in the housing situation until we return to the days of the speculative builder and through the natural wealth-making qualities of profit-making and bankruptcy, over-production and under-production, good and bad, retrieve that resilience and variety which, in later Victorian days, taught us all we know about the possibilities of houses and home making.

Housing is capital, and the lack of capital is a good big part of our trouble. When the coal trade is flourishing wages are paid to miners, and wages seem on the surface to be of first importance when we are considering unemployment. It remains true, however, that every ton of coal mined is so much capital exhausted, while every house built is so much capital created. Capital in the form of a house is capital with a maximum of reproductive power and from the point of view of society, if not of the landlord, there is no better investment than houses. This is not merely because a house lasts for a long time, but because during every day of its existence it is an active promoter of trade and employment. I am, indeed, inclined to doubt the wisdom of building houses to last a century, and I rather prefer the American view which puts the proper life of a house at twenty years. From the public point of view, a twenty-year house may be as good an investment of capital as one that stands for the ninety-nine years of a lease. A series of twenty-year houses yielding, say, 15 per cent. interest to their owners, would be far better for owners and occupiers and everybody else than the present long-dated 4 per cent. idea of the way the housing and landlord trade should be conducted. But, whichever way you look at it and whoever builds houses or, for that matter, whoever owns them, they are the most valuable form of capital that any nation can possess.

Six Million Replacements

Whether we take the long or the short view, we must come to the conclusion that to allow the housing market to retain its present restricted character is sheer folly. Our lack of proper houses offers more work than could ever be done by all our unemployed. The figures are, roughly, these. We have 10,000,000 families and 8,000,000 houses, but of these not more than a quarter give us real satisfaction. If we consider one house per family a proper standard to aim at, there are orders waiting for 2,000,000 new houses and 6,000,000 replacements; if we go further and accept the twenty year American idea, we find that we have a regular market for half-a-million houses a year. Nothing short of a perfectly free market, subject to all the stimulation of open competition, will even scratch the surface of this mine of national wealth.

There are quite enough natural and necessary difficulties about the building of a house to make it very important to keep the market clear of troubles that can be prevented. The scarcity of land, the risk of fire, the need for drains and water, all tend to limit our ability to satisfy the full demand, and we should therefore take special care to see that no monopolies, whether of materials or labour, or worst of all the monopoly of public ownership, are allowed to damp down enterprise.

We must really retrace our steps in this matter of housing. We were over-building within living memory, and we all know how it was done. Surely we should be delighted to see a condition of over-building to-day. No better social service is possible, and yet we hesitate. One final point. All this talk about housing for the working classes must be recognised as retrograde nonsense. We do not build bicycles or make gramophones for the working classes, then why houses? The builders must be free to build for anybody who will pay them.

On the question of unemployment, therefore, building helps us in a double way. It offers unlimited prospects of work first on the building itself, and secondly and subsequently on all the other processes and operations which come into play as soon as a house is available.

Housing is the master key to the situation.

A General Survey of the Solvents Industry

By Rex Furness

In the following article, Mr. Rex Furness, who has been for some time interested in the study of solvents, presents a general survey of this increasingly important industry. Without attempting to cover exhaustively so wide a field, it indicates the intensive investigation into the chemistry of solvents that has brought the industry up to its present standard and the importance and variety of the industrial applications of solvents.

EVER since the days of the old alchemists—those worthy experimentalists who pursued their quest for the philosopher's stone and the elixir of life—right through the middle ages of chemistry to our own times of highly industrialised chemistry, solvents have attracted the attention and study of investigators. It was in the search for materials that would "dissolve" the noble metals that alchemists discovered many of our well-known acids—*aqua fortis*, *aqua regia*, the vitriols, etc., whilst it was perhaps Van Helmont who first recognised the true nature of solvents proper and knew that a metal "dissolved" in acid could be recovered therefrom by suitable means. Van Helmont, too, pursued the search for a universal solvent, "alkahest," which should also be a universal medicine to cure all the ills of body and mind. It is, however, upon the more or less modern knowledge that there is no such thing as a universal solvent that the importance of solvents to mankind has been founded.

It is somewhat difficult to define a solvent in brief terms, but we may take it that a solvent is a material, usually liquid, which will take up into itself another material—solid, liquid or gas—and form a homogeneous phase from which the dissolved material, the solute, can be readily recovered.

Solvents known to-day are, as we have said, specific and not general in their properties, and different solvents may therefore be used to dissolve different materials. In this way the uses of solvents are manifold, and may very broadly be summarised as follows :—

1. The production of a homogeneous phase, a solution of one material in a suitable solvent, for use in the operations of crystallisation, chemical reaction, coating surfaces, making films, etc.

2. The extraction of a desired material from a residue of insoluble material—the residue being sometimes useful in addition.

3. The removal by solution of an undesirable material, an impurity, from an insoluble valuable residue. Here, again, the solute may at times be also worth recovery.

It is by a very brief survey of these typical applications of solvents that we may envisage the multifarious uses of solvents and their importance in modern industry.

Homogeneous Solutions

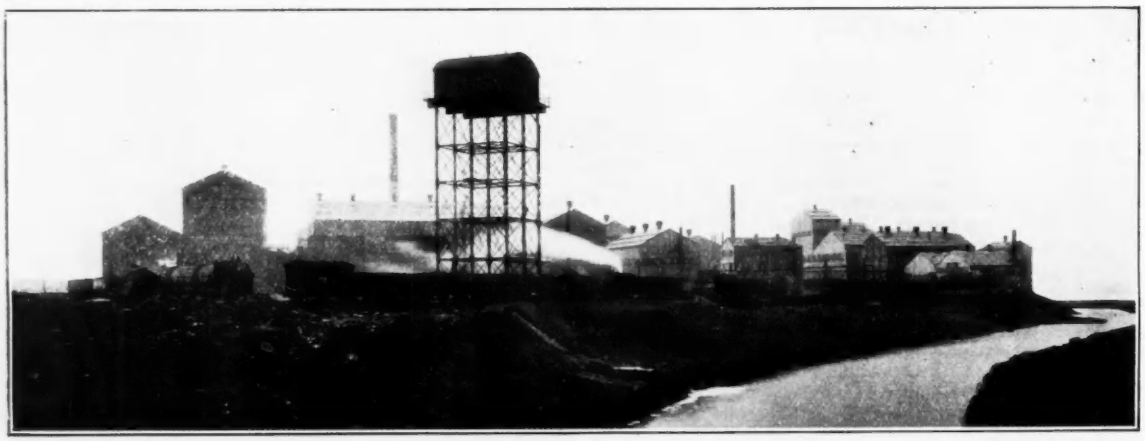
Water, the nearest approach perhaps to the "alkahest," dissolves many substances readily, and the solutions of salts, acids and bases are very largely employed for facilitating a host of chemical reactions which need not even be exemplified. Purification by crystallisation from aqueous, or indeed other, solution is again too familiar to demand illustration. Drugs are dissolved in various solvents in order to facilitate preparation of standard solutions and correct small dosage, whilst the use of "standard" solutions in analysis merely needs mention.

Homogeneous solutions in a variety of solvents of many materials are used for coating work in painting, lacquering, film production, etc., and mention may be made in particular of the pyroxylin lacquers which are now so firmly established for finishing motor car bodies. Special mention is made of these lacquers, since it is largely due to their growing utilisation that many new organic solvents have come to be made in large amounts—esters, ethers, keto-alcohols, mixed ester-ethers of dihydric or polyhydric alcohols, etc. Pyroxylin or nitro-cellulose solutions in hydrocarbons are largely used in the production of artificial leather. Acetone and alcohol-ether mixtures are made use of in the homogenisation of gun cotton—nitro-cellulose again—and nitro-glycerine, etc., in cordite manufacture, the solvent being subsequently evaporated as in the cases above of the production of artificial leather and coatings of pyroxylin upon motor car bodies, metal and woodwork, etc.

The use of alcohol for dissolving gums, shellacs, etc., in the making of varnishes and polishes, and the application of turpentine and solvent naphtha for similar purposes are well known, and must serve to end our illustrations of the use of solvents for making homogeneous solutions for a multitude of purposes.

Extraction

As solvents properly chosen have a specific dissolving effect, it is clear that they may be used for extracting a desired material from admixtures or conglomerates. Hence we find petroleum spirits, chlorinated hydrocarbons, etc., being used in the process of oil and fat extraction from oil seeds, nuts and kernels, etc. The solution of oil obtained in full yield from the seed—as contrasted



VIEW OF THE WORKS OF CHEMICAL AND METALLURGICAL CORPORATION, LTD., FROM EAST SIDE (SEE ARTICLE ON PAGE 602).

with a partial yield only when hydraulic pressing methods are employed—is heated to evaporate the solvent, and the oil or fat is recovered for further purification or direct use. The residues, though not truly "oil cake" such as naturally results from pressing operations, are not without value as feeding stuffs.

In oil and fat extraction, petroleum spirit is probably the most widely used solvent, but it involves a considerable fire risk, which can be entirely avoided by the use of the non-inflammable dichlor and trichlor ethylenes which, unlike certain older chlorinated hydrocarbons, are not readily hydrolysed to form hydrochloric acid which naturally is destructive to plant constructional materials.

The uses of various solvents, ether, chloroform, alcohol, benzene in the extraction of drugs, alkaloids, fine chemicals, perfumes, in the working up of gland extracts, synthetic organic chemicals, etc., and for similar purposes, can only be mentioned under this heading.

Purification

It is frequently possible to extract an impurity from a desired product by selective solvent action. The first obvious instance is in the washing of precipitates in ordinary or vacuum filters, in filter presses or continuous filters, etc., free from "solubles" by means of water. Specific solvents are known for gases, so that hydrogen used in synthetic ammonia operations is freed from carbon dioxide by dissolving the latter in water under pressure and from carbon monoxide by dissolving it out by means of cuprous salt solutions. Similarly, although perhaps not quite correctly placed in this section, the ammonia itself is removed from the uncombined circulating gas mixture of nitrogen and hydrogen by solution in water.

The extraction of hydrogen from the gases produced in the Bergius process of coal liquefaction may come to be effected by fractional solution methods, and so make the process self-supporting in the matter of hydrogen, the costliest single factor standing in the way of immediate economic application of the coal liquefaction process.

General

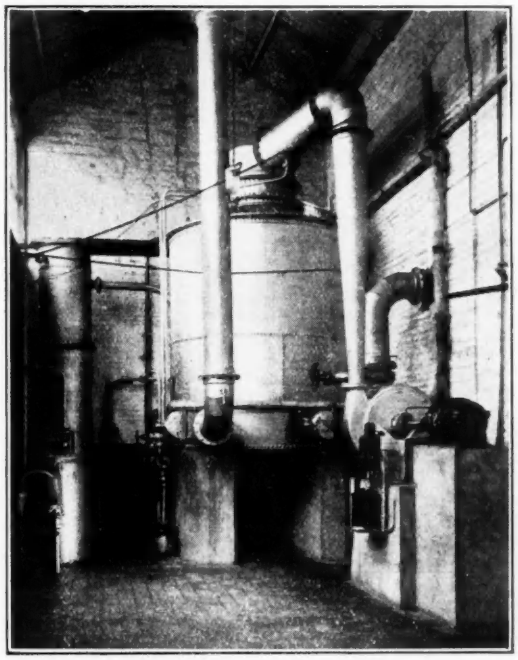
Although it has been attempted broadly to illustrate the uses of solvents in the above three groups, there are important applications which must be alluded to in addition. Alcohol is largely used in the production of transparent soaps, a colloidal solution setting to a gel which retains its structure substantially and its transparency almost completely after the solvent has been removed by evaporation.

"Nitro" artificial silk is spun from a solution of nitro-cellulose in alcohol and ether which evaporate as the filaments emerge from the spinarette orifices. Similarly, acetone is employed to dissolve cellulose acetate and the solution is forced through tiny orifices in the spinarette to form "acetate" silk filaments as the solvent evaporates.

Solvents are largely used in cleaning operations, as, for instance, in the so-called "dry cleaning" of clothes. Petroleum spirit dissolves grease and loosens dirt, and the cleansing is facilitated as a whole by the presence of specially soluble soaps in the solvent. Solvents are used to some extent, and might profitably be more widely used, in wool scouring operations, whilst quite a number of different types of solvents are used for incorporation into ordinary soap in order to confer special cleansing properties. Thus naphtha, turpentine, trichlor ethylene, carbon tetrachloride, cyclo-hexanol, methyl cyclo-hexanol, ethylene glycol ethers, etc., find use in the so-called "solvent" soaps.

Study of Solvents

The properties of the many solvents now available have been studied with care and thoroughness in order that the most suitable solvent for any particular purpose can be chosen, but it is only possible in a brief article to indicate the lines taken. The extent of solubility of materials in



Solvent Recovery—A Plant, designed and erected by the Societe de Recherches and d'Exploitations Petroliferes, with single absorber, using Acticarbone for recovery of Benzine. Capacity 110 gallons per 24 hours.

solvents, the influence of temperature, the change in specific solvent properties with change in temperature, the influence of pressure upon solubility and specific solubility—particularly in the case of the solution of gases—and the mutual miscibility of solvents have received full attention. As a modern instance of this type of work may be cited the examination of a wide range of solvents for nitro-cellulose lacquers. Some materials readily dissolve the nitro-celluloses but not resins and gums, which must be present in a complete lacquer. Other solvents take up the resins, etc., but not the nitro-celluloses, and hence the study of mixed solvents is of vital importance. Further, solvents which dissolve both nitro-celluloses and resins are being found.

The physical factors of boiling point, vapour pressure, rate of evaporation (which does not necessarily follow proportionally the vapour pressure), specific heat, latent heat, inflammability, explosive range in air, etc. are known for many solvents, and these factors frequently determine the suitability or otherwise of a particular solvent for a certain purpose. Boiling point and rate of evaporation are perhaps of major import in the case of pyroxylin lacquer solvents, for which the so-called high boiling and low boiling solvents are available in profusion, as well as diluents, softeners and plasticisers which are, of course, not necessarily solvent for the lacquer constituents. Latent heat and specific heat are of prime importance for extraction recovery processes, where fuel economies in solvent evaporation from solution during recovery operations must receive consideration.

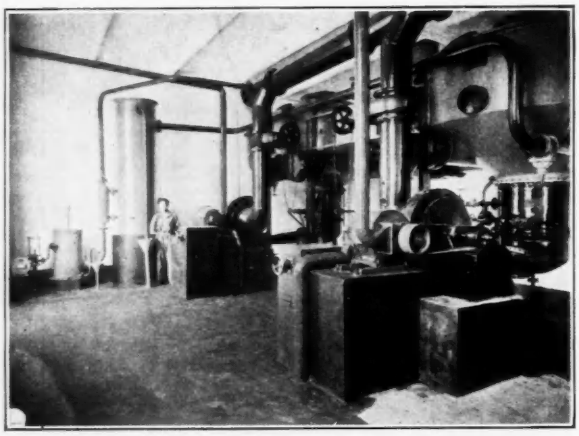
Inflammability, explosibility, etc. naturally demand consideration, whilst chemical change (for instance, hydrolysis in the case of chlorinated hydrocarbons with formation of destructive hydrochloric acid) may sometimes discount the otherwise valuable properties of a solvent.

This matter of the study of solvents must be left with the general statement that all the properties of modern solvents which determine their applicability in different circum-

stances have been investigated and are known with exactitude.

The Manufacture of Solvents

In outlining processes for the manufacture of some of the principal solvents, we may first allude to the production of distilled water by economic plant, to the somewhat



SOLVENT RECOVERY—A RECOVERY PLANT WITH TWO ABSORBERS, DESIGNED BY THE S.R.E.P. IN AN INDIA RUBBER WORKS. CAPACITY 300 GALLONS SOLVENT NAPHTHA PER 24 HOURS.

cheaper "electro osmose" water which may frequently take the place of distilled water and to treated water for boiler purposes where many of the salts present as solutes in ordinary water are removed from solution by precipitation or exchanged for salts less harmful to boilers—that is, removal of hardness-forming salts or their conversion to non-hardness-forming salts. The principles of solution are largely involved in these processes.

Methyl alcohol is made synthetically in this country and ethyl alcohol by fermentation. Elsewhere the alcohol is made by fermentation processes, from ethylene via ethyl sulphuric acid and from acetylene via acetaldehyde.

Acetone is manufactured from calcium acetate and by fermentation processes—together with butyl alcohol—in this country, whilst synthetic processes in which acetylene serves as starting material (being converted to aldehyde, acetic acid and acetone) are worked abroad and may soon mature here.

Chlorinated Hydrocarbons

This country has a large industry concerned with the production of the many chlorinated hydrocarbons such as trichlor ethylene, carbon tetrachloride, hexachlor ethane, etc., and large amounts are produced. Carbon bisulphide is also made in quantity.

Ethylene glycol is made from ethylene via the chlorhydrin, but abroad cheap ethylene from natural gas serves as starting point for the manufacture of ethylene dichloride and the glycol. From the latter are made the ethers and esters which are prominent pyroxylin solvents.

Scores of esters, a few years ago mere laboratory chemicals, are available from British factories to-day, as are cyclo hexanol, methyl cyclo hexanol and their esters and corresponding ketones. Ketols, keto-alcohols, ketones, and a range of special solvents are also recent products of British fine chemical industries, although the quantities made almost bring them to be regarded as "heavy" chemicals.

Petroleum spirit and other mineral oil solvents are naturally largely of foreign origin, although much refining of mineral oils is effected at home with the consequent production of high class, well-defined "cuts" or fractions of special solvent value. British industry also provides coal tar solvents such as benzol, toluol, xylol, solvent naphtha, etc., but turpentine has to be imported.

It may truly be said in broad generalisation that unless supplies of essential raw materials are not forthcoming from home resources or are too dear to import, the British chemical industry produces solvents in as cheap a way and in as pure a condition as any other country, and we may feel well content with the home production of a wide range of solvents for all purposes.

The Recovery of Solvents

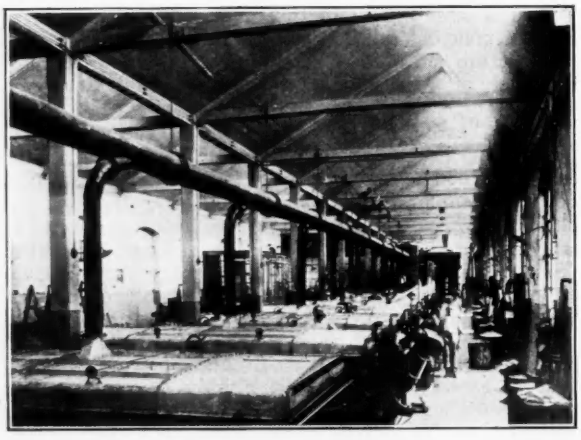
Users of solvents may be only generally interested in their manufacture, but they are undoubtedly vitally concerned with solvent losses and therefore with solvent recovery processes. In the manufacture of artificial silk, imitation leather, transparent soap, in oil and fat and general extraction processes and elsewhere, large amounts of volatile solvents escape into the air, and it is an economic desirability, maybe a necessity, to recover a substantial proportion for re-use.

The older methods of water or dilute acid scrubbing, etc., are being improved by careful design of apparatus and study of fundamentals but are, in addition, being replaced by the use of more effective scrubbing liquids such as the cresols, hydro-naphthalenes and phenols and principally by solid absorbents. The latter, charcoal and inorganic gels, absorb large amounts of volatile solvent vapours even from very low concentrations in air, so low as to be incapable of being effectively dealt with by normal liquid scrubbing methods.

"Regeneration"

The solid absorbents are "regenerated" after absorption has reached a definite capacity figure and are then ready for a further absorption run, the cycle of absorption and regeneration being continued more or less indefinitely. The inorganic gels are now available at prices which render them more attractive than imported activated charcoals, and they are hardier and more lasting in use—a most important qualification.

British manufacturers of the gels and suitable plant for solvent recovery from process air or gas or from storage



SOLVENT RECOVERY—A SPREADING ROOM IN AN INDIA RUBBER WORKS, SHOWING AN S.R.E.P. COLLECTION SYSTEM FOR THE SOLVENT VAPOUR.

tanks, are paying assiduous attention to the important problem of solvent recovery in manufacturing operations.

We feel that throughout this article, condensation has had to be ruthlessly pursued so that only a broad picture of the various matters dealt with may be presented. Further details will be gladly supplied to interested readers.

Solvents: Their Manufacture and Uses

By Major Denis J. Burke, O.B.E.

(of the Commercial Solvents Corporation).

Of particular interest is the following very clear description by Major Burke of the manufacturing processes of the Commercial Solvents Corporation, by which a great variety of solvents are produced from the raw materials corn, coal, and water.

WHAT do we know about solvents? One moment's reflection on the question brings one face to face with the fact that solvents are the very life-blood of several of our most important manufacturing processes. For instance, the growth of the great modern industry of nitro-cellulose lacquers and enamels was only made possible by the provision of an abundant supply of cheap and reliable butanol (normal butyl alcohol) and its derivatives; the artificial silk industry depends upon immense quantities of acetone; manufacturers of numerous useful substances, from anæsthetics to the xanthates used in ore refining, look to the solvent manufacturers for their basic materials.

And yet, indispensable as solvents are to the industrialist and technician, they rarely appear in the articles that reach the general consuming public. Ships, hotels, houses, motor cars, furniture and a host of articles in everyday use are decorated with the new and superior lacquer finish, but no butanol remains in the actual lacquer coat, no acetone in the artificial silk fabric as it reaches the markets.

For this reason the general public are unaware of the immensity and importance of the solvent industry; in fact, many technical men not directly interested in research or manufacture involving the use of solvents are but dimly conscious of the developments in this field of industry.

A Great American Enterprise.

To understand something of the details and scope of solvent manufacture a brief examination of the activities of a great enterprise entirely devoted to the production of solvents will enable one to appreciate the ramifications of these operations. The Commercial Solvents Corporation were the pioneers in the manufacture of butanol (normal butyl alcohol) by the fermentation process. The fact that their activities made available abundant supplies of butanol and its derivatives and acetone and its derivatives made the modern nitro-cellulose lacquer industry possible. They are the largest lacquer solvent makers in the world, therefore it will be of interest to examine the development of this industry and the nature and variety of the products produced.

The principal products manufactured by the Commercial Solvents Corporation are:—

Chemical Products.—Acetone, and its derivatives; butanol (normal butyl alcohol) and its derivatives; ethyl alcohol, denatured; and methanol, synthetic.

Milling Products.—Corn bran, corn oil, and corn germ meal.

The two factories of the Corporation are situated, one, in Terre Haute, Indiana, and the other in Peoria, Illinois. Both factories are in the "corn belt" of America, both are on rivers and both are adjacent to coal mines. As corn, coal, and water are all the materials required by the manufacturing process of the Commercial Solvents Corporation, it will be realised that the factories are well situated for the production of solvents under favourable and economic conditions.

The growth of the demand for the products of these factories can be estimated from the fact that during 1920 the first year of operation, 400,000 bushels of corn were converted into solvents, and in 1928 more than 8,000,000 bushels of corn were so consumed.

Manufacturing Process

While corn or starch is the essential basic material of this process, it would be useless for the production of solvents were it not for a bacterium or minute organism which has the unique ability to convert corn into chemicals. This bacterium is called *clostridium acetobutylicum* and was discovered by Dr. Charles Weizmann, the eminent English chemist, and its use throughout the world is protected by letters patent vested in Commercial Solvents Corporation.

The manufacturing process is extremely simple and may be divided into four steps: the preparation of the corn, the propagation of the bacteria, fermentation and distillation.

Preparation of Corn.—The corn is ground by milling operations. The corn kernel is separated into three portions, bran, crude starch, and the oil-carrying section called "germ." The oil is carefully pressed from the germ and finds a ready market amongst salad oil and soap manufacturers. The residue of germ and the corn bran are both widely used in animal feeding.

The crude starch which the bacteria will convert into solvents is mixed with water in large vats, run into closed tanks, where it is completely sterilised by heating at a high temperature. When sterilised the corn paste is cooled and goes to 50,000 gallon tanks, where it is subjected to the action of the bacteria.

Propagation of Bacteria.—The masses of bacteria are secured by continuous propagation from a few individuals. The bacteria are propagated until they have so increased in number that there is a sufficient amount to act on the charge of a 50,000-gallon fermenter. In five successive days a few bacteria multiply so enormously in number under controlled conditions that, commencing in a small glass tube, they are successively transferred from the glass tubes to one quart glass flasks, to 10-quart glass flasks, to 80-gallon steel culture tanks, and finally to 800-gallon tanks. After the fifth day of propagation, there are a sufficient number of bacteria in the 800-gallon tank to act on the 40,000 gallons of corn starch paste in the 50,000-gallon fermenters. The Peoria works have 96 such tanks and the Terre Haute works have 52.

Fermentation.—After the 50,000-gallon tanks—called "fermenters"—have been charged with 40,000 gallons of corn starch paste, the requisite quantity of bacteria is added and the process of fermentation begins. The bacteria produce not only solvents, but great volumes of the gases carbon dioxide and hydrogen. Forty-eight hours after the corn paste and the bacteria have come together, the fermentation is completed, the starch has all been converted into the solvents butanol, acetone, and ethyl alcohol, and the gases carbon dioxide and hydrogen.

Distillation.—After fermentation, the butanol, acetone, and ethyl alcohol are separated one from the other by distillation. Methanol, commonly known as "wood alcohol," is manufactured by the chemical union of the gases carbon dioxide and hydrogen given off during the course of the fermentation of the corn starch. The gases are led from the fermenter tanks, "scrubbed," subjected to high temperature and pressure, and forced through a "catalyst." This "catalyst" converts the two gases into the liquid methanol, which is chemically identical with that produced from wood.

Products and their Uses

A research staff of 50 bacteriologists, chemists, and engineers are constantly at work endeavouring to improve existing processes and to develop new ones. A research information service and a patent department maintain constant contact with developments all over the world.

Butanol, the principal product of Commercial Solvents Corporation, finds its largest use in the manufacture of lacquer, but butanol and its compounds are employed in more than 40 other industrial processes ranging from the refining of oils to the manufacture of textiles and dyestuffs.

Acetone serves a diversity of purposes. The artificial silk industry, the manufacture of photographic film, storage of acetylene, certain processes of oil refining and welding of steel and the extraction of oils all require acetone.

Diacetone alcohol, a derivative of acetone, is used in the manufacture of shoes, in hydraulic braking systems, and in finishes for artificial leather.

Ethyl alcohol, denatured, is an essential in almost all chemical and pharmaceutical manufacturing processes, and is the basic material for such products as ether and ethyl acetate.

Methanol is a product of great industrial importance. It is the basic material for the manufacture of formaldehyde and so finds its way into synthetic resins such as "Bakelite."

Design and Operation of Solvent Extraction Plants

Some Practical Observations: By James MacGregor, M.I.Chem.E.

(*Managing Director of George Scott and Son (London), Ltd. and Ernest Scott and Co., Ltd.*)

Mr. McGregor, a recognised authority on chemical engineering plant in many branches, discusses the practical problems to be solved in the design of plant for solvent extraction. Emphasis is laid on the great variety of conditions to be provided for and on the vital importance of sound experience as well as sound theory if the plant is to perform its functions efficiently.

THE field of application of solvent extraction is an ever widening one, and scarcely a month passes but some new problem is presented to the chemical engineer specialising in solvent extraction work. By the introduction of new solvents, and better methods of applying solvents already widely used, materials which have been regarded in many instances as not lending themselves to solvent extraction have been brought within the scope of this treatment. In directions where solvent extraction was once regarded as uncommercial, improved methods, reduced steam and labour charges, and, above all, reduced solvent consumption have widened the application of this process.

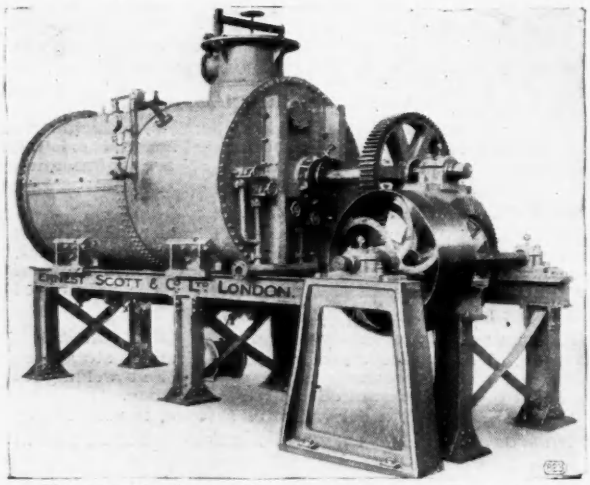
Chemical Engineering Problems

At one time Continental makers of solvent extraction plants had a standard design which was offered indiscriminately for almost any class of material. Very little regard was paid to the nature and condition of the raw material, to the fat, grease, or other soluble content, or to the moisture remaining in the extracted residue. These days have long since passed. Users of solvent extraction plants to-day are quick to appreciate the features of a well-designed plant, and the study which has been devoted to evolving equipment adapted to the treatment of the materials users may be concerned with.

In approaching a solvent extraction problem, the first consideration is the nature of the material and the conditioning or preparation thereof to facilitate the extraction of the soluble constitutents to be removed.

Many materials contain a percentage of moisture which it is desired to retain in the extracted residue. Where such material, in its raw state, is graded so that extraction may proceed without crushing, grinding or milling, and where the material is such as to lend itself to simple percolation, the proposition is easy.

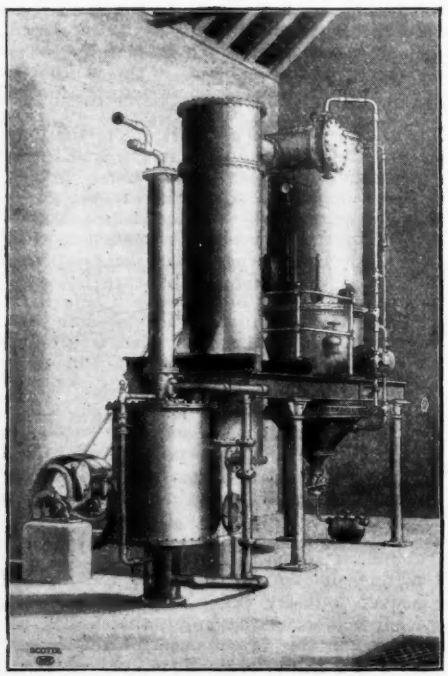
Certain raw materials may contain a very high percentage of moisture. In many quarters it is still held that efficient extraction cannot be attained until the moisture present has been eliminated. While this is undoubtedly true in many instances, it has been proved that high efficiency extraction can be effected in the presence of moisture. In such cases it may be necessary to reduce the raw material to a condition of pulp.



HORIZONTAL STEAM-JACKETED SOLVENT EXTRACTION PLANT WITH AGITATORS.

Sometimes coagulation of certain bodies is called for, while in other instances a preliminary cooking or other treatment serves to facilitate extraction. Each problem must be carefully considered before the design of the plant is proceeded with.

Not only is it correct that the soluble constitutents in many materials may be efficiently extracted in the presence of moisture, but it is found in certain instances that the addition of moisture is distinctly helpful. A patented process exists



SCOTT PATENT VACUUM STILL.

based on this principle and has been made use of in the extraction of an edible fat which has a very large consumption in the United States.

Having determined what is necessary in the preparation and conditioning of the material prior to extraction, the chemical engineer must then decide whether percolation, decantation or a combination of both will prove most efficient. In some instances it is essential that extraction be carried out in the cold. Under other conditions control of the temperature is called for. Generally, however, the soluble constituent is more readily removed by means of hot solvent in the form of liquid or vapour.

Wherever percolation is feasible, this should be resorted to, but materials in a fine state of division are encountered where percolation is impossible.

When the method of extraction has been arrived at, consideration must then be given to the question of extraction in stationary vessels or otherwise. Extractors of horizontal design may be stationary with agitators, or alternatively of rotary type. The rotary design has not been largely adopted in this country. It has met with more acceptance in the United States and on the Continent.

Materials exist which do not lend themselves to extraction in the ordinary vertical extractor or even in the horizontal type. Where extraction is possible by percolation and where the solvent has subsequently to be recovered without the introduction of open steam into contact with the residue, there is a patented design available which is a combination of percolating tube and solvent recovery vessel, with a patented valve interposed between the percolating tube and the solvent recovery vessel below. In this particular plant it is possible

to carry out extraction in the percolating tubes above, while recovery of the solvent is proceeding in the steam-jacketed recovery vessel below, thus approaching as nearly as possible continuity of operation.

Solvents and Solvents Recovery

With the design prominently in view, regard must be had to the solvent to be employed. Where restrictions are enforced prohibiting inflammable solvents, non-inflammable solvents are available. In studying the solvent to be used, attention must be given to what must be achieved in process of extraction. If during extraction it is essential that a certain amount of moisture must at the same time be eliminated, this has some bearing upon the distillation range of the solvent.

The solvents most generally in use are petroleum benzine and trichlorethylene, the latter coming within the non-inflammable category. Both solvents are now available at reasonable prices. Producers of petroleum benzine are specialising in the preparation of grades for particular purposes, the distillation range being comparatively short.

Where such solvents are not admissible, others are procurable, and although these may prove more costly, with the efficiency now attained in the recovery of these solvents the cost of solvent as an item of the process is not always the most formidable charge.

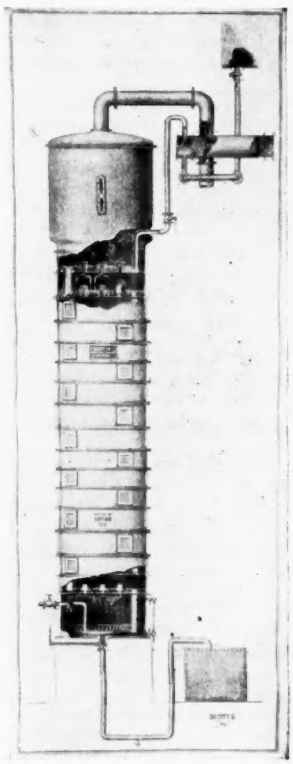
Having arranged for the most efficient removal of the mixed solvent from the extractor, there remains the question of recovering the solvent from the residue. This demands a knowledge of the behaviour of the material in contact with open steam alone or dry steam alone or a combination of both. Where recovery of the solvent from the residue is permissible by means of open steam in direct contact with the material and without agitation, this is desirable. Other materials permit of the recovery of the solvent by means of open steam when facilitated by agitation. Where the extractor is of the steam-jacketed type, dry and open steam may be employed, or dry steam alone. Dry steam applied through a steam jacket does not usually eliminate the solvent rapidly except at reduced pressures.

Where recovery of the solvent is possible without resorting to a reduced pressure, this again is very desirable, for when reduced pressures are employed in the recovery of solvents a further problem is introduced in the recovery of the solvent from the partially saturated air or distended vapour issuing from the plant.

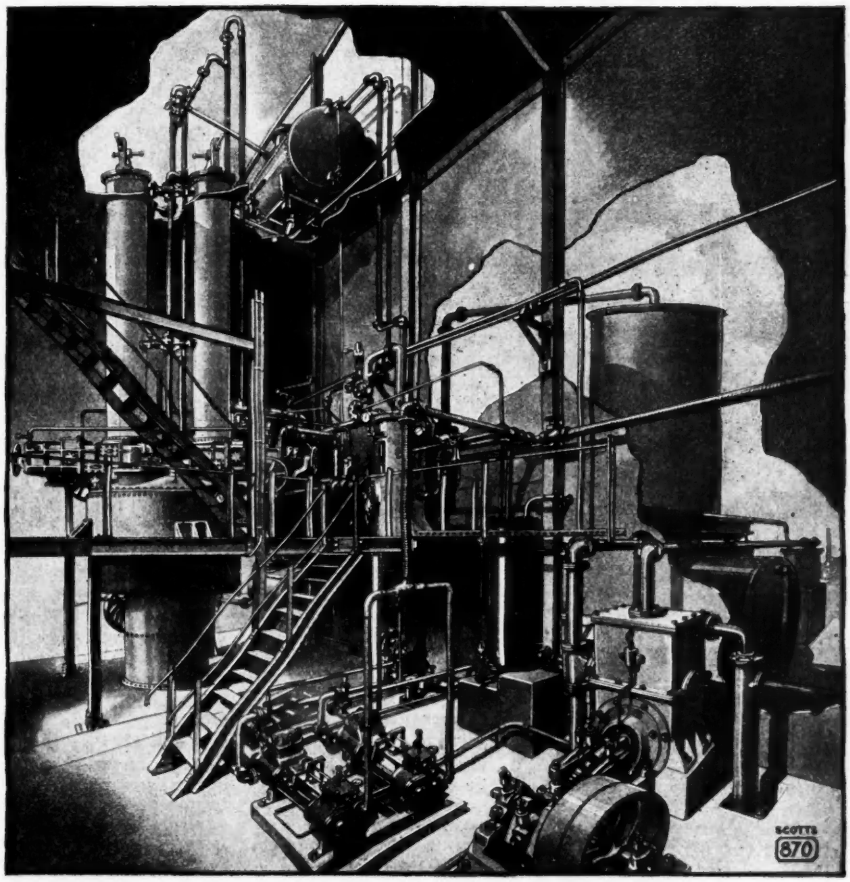
Much depends upon what is required in the condition of the extracted residue. In many cases the moisture content and the colour of the material are of importance. These factors have a considerable bearing upon the method employed for recovering the solvent in the final stages of the operation. In an efficiently designed plant, operating under reduced pressure, it is possible to eliminate the solvent rapidly without the introduction of open steam. With solvents of suitable distillation range all traces of the solvent may be eliminated, for while an expert in the materials under treatment might determine that the residue had been subjected to treatments by solvents it would be quite impossible to find any trace chemically of the solvent in the material itself.

"Breathing" of the Plant

In designing an efficient plant, scrupulous care must be devoted to the movement of the air contained within the apparatus. Obviously, when an extractor is brought into operation a certain volume of air must escape from the plant, but when that air has been eliminated a condition of balance is attained until the cooling stage is reached, when a certain intake of air may be encountered. The plant should be so designed that the air contained in the various parts of the equipment may move from part to part of the plant as the solvent is moved. In other words, or as it is generally understood in the trade, the "breathing" of the plant must be carefully considered.



Scott Patent Continuous Still.



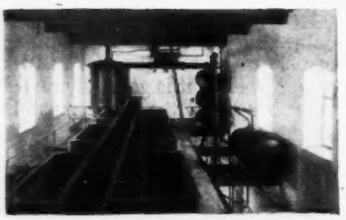
Scott Patent Percolating and Dry Solvent Recovery Extraction Plant.

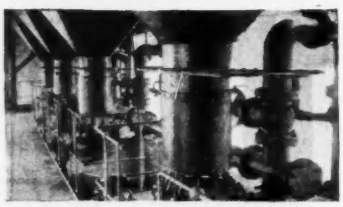
In the recovery of the solvent from air or distended vapor escaping from the plant, it is possible to effect a very high recovery by means of activated carbon or other adsorbent. Where, however, the soluble constituent removed in the process is a liquid oil, use may be made of that oil in the recovery of the solvent from the air or distended vapour. On these lines remarkable efficiencies can be attained in the consumption of solvent in process. The actual volume of solvent in process is of no particular moment. The vital factor, from the point of view of the user, is the loss per ton of material treated or per ton of the extractable constituents obtained.

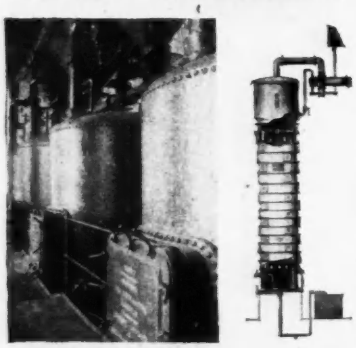
General Conditions

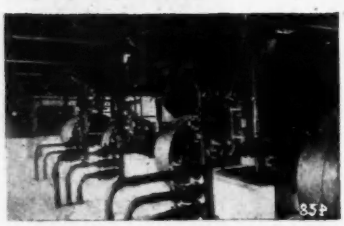
It is unnecessary to point out that other considerations also play an important part in the design of an efficient plant, such as the climatic conditions under which the plant is required to operate. Where it is intended to operate such plant by means of native labour, the plant should be of the simplest possible type. The design should be as fool-proof as possible. This calls for the fitting of adequate safety devices so that, should an operator fail to open the control valves, no disastrous effects may result. An added precaution lies in the duplication of these safety devices.

A particularly useful arrangement is a combined type of safety valve where the enclosed valve releases the vapour to the condenser and at excessive pressures the second safety valve releases vapour to atmosphere, thus quickly bringing to the attention of the operator the fact that some irregularity is occurring.







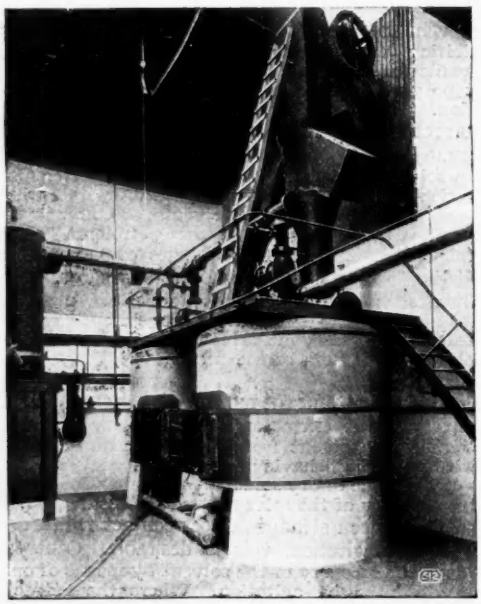


VERTICAL SOLVENT EXTRACTION PLANT WITH AGITATORS.

Having extracted the soluble constituents from the raw material, the recovery of the solvent from the extract follows. This again demands some consideration. In many instances it is not permissible to bring open steam into contact with the extract. In such cases it is customary to recover the solvent under vacuum. Where the use of open steam is permissible, or a combination of open and dry steam, without the application of vacuum, this undoubtedly forms the simplest arrangement. Vacuum stills in single and multiple effect are in daily use.

A very efficient type of recovery still is the continuous still illustrated. This depends entirely on the use of open steam, although the use of heating coils or hot plates in such a still has been found advantageous. A still of this design always proves efficient from the point of view of steam consumption, and the operation of the still can be made practically automatic. Such continuous stills may also be operated under vacuum.

Much attention has been devoted to the design of continuous extraction plants. The Patent Office derives no little revenue from this source, but few of these designs have been developed to any really commercially attractive stage. Naturally, the user wishes to know the advantages. Unless it can be proved that continuity of operation will effect a reduction in capital cost, labour, fuel, or in the percentage of soluble material left in the extracted residue, the attractions of continuously operated plants are somewhat illusory.



VERTICAL SOLVENT EXTRACTION PLANT WITHOUT AGITATORS.

The breaking of a single link in the cycle of operations brings a continuous plant to a standstill, whereas the small attentions required from time to time on separate parts of an intermittent plant do not result in the entire stoppage of the process.

No attempt has been made in these notes to deal with the scientific aspect of solvent extraction. These observations are put forward from a practical study of the problems confronting the chemical engineer in designing plant to meet the conditions of operation, the characteristics of the material to be treated and to obtain the products aimed at. These remarks may serve to indicate how necessary some real experience is in this particular line if the plant is to prove efficient from every aspect and a real asset to the user

Boots Pure Drug Co.

Work of the Research Department

MR. J. C. BOOT presided at the 42nd annual meeting of Boots Pure Drug Co., Ltd., held at Nottingham on Tuesday, and announced that the sales and number of customers were again a record.

During the year their research department had discovered a number of synthetic chemicals suitable for use in medicine. One of these substances, amyl-*meta*-cresol, had 250 times the antiseptic value of phenol and was of very low toxicity. They were actively investigating the possibility of extending its use in all those branches of medicine where antiseptics of this type were essential. This substance was also giving promising results as an intestinal and urinary antiseptic. Its discovery might be considered to be one of the biggest advances made in recent years in the search for the ideal antiseptic.

As an instance of the high standard of the work carried out in the research department, the chairman mentioned that the results of some of their scientific investigations had been described in six contributions to the journals of learned societies in the course of the past twelve months.

The number of employees had risen by over 700 during the year and now totalled 17,000, the highest figure in the history of the company.

Solvent Recovery

The Advantages of Acticarbone

WITH the increasing use of expensive solvents and the need for economy in industry, the question of solvent recovery in india-rubber, silk, celluloid, artificial leather and similar manufacture, is becoming more and more important. The Société de Recherches and d'Exploitations Pétrolifères has devoted years to the technical and practical development of their processes and are now producing an activated charcoal, Acticarbone, which has unique properties for solvent vapour absorption. With the application of this by their patented processes of heating and cooling and keeping the carbon always perfectly dry, they are obtaining very high yields of solvent recovery with great safety and simplicity.

About 50 plants have been erected in Europe already, many of which have been in operation for many years. These effect the recovery of benzol from coal gas, gasoline from natural oil gas, solvent naphtha in waterproofing and india-rubber works, ether, alcohol, acetone, etc., in silk, artificial leather and celluloid works, etc. The activated charcoals—Acticarbone—are also made for decolorising all types of liquids and solutions, for drying gases, for desulphurisation, and depolarisation in electric batteries..

The sole representatives for Great Britain and the Colonies are Price, Stutfield and Co., Ltd., 6, Fenchurch Buildings, E.C.3, who will be pleased to give all technical information, while the Research Laboratories, and all the experience of the Société de Recherches and d'Exploitations Pétrolifères are at the disposal of clients.

The Cyclohexanol Series

Wide Field of Employment

IN the varnish, laundry, textile, artificial leather, polish, lacquer and soap trades, to mention but a few, the cyclohexanol series of solvents have effected not only great improvements in results, but also very considerable economy in working costs. These cyclohexanols include cyclohexanol, methylcyclohexanol (sextol), cyclohexanone (sextone), methylclohexanone (sextone B.), cyclohexanol acetate, methylcyclohexanol acetate (sextate), cyclohexanol oxalate, methylcyclohexanol oxalate (barkite), and cyclohexane.

The most striking feature about the cyclohexanol solvents is the large variety of purposes for which they are used, due especially to their high solvent powers for an exceptionally wide range of substances. In the cellulose lacquer trade, the ketones and esters of this series are valuable on account of their high solvent power on nitrocellulose, a large number of gums and resins, oils and dyes, etc. They impart good flow, gloss and resistance to blushing, and the oxalates, besides possessing good plasticising power, have a very high resistance to ultra-violet light.

Good Solvents for Oils

For these reasons the cyclohexanol solvents also prove most valuable in the film, artificial leather, synthetic resin and plastics, printing and other trades. In polishes they are doubly useful on account of their good solvent power for waxes, and also for oils, grease, etc. The solvent power of these ketones and acetates for crude rubber is appreciably greater than that of many of the more common rubber solvents, while their unusual property as solvents both for rubber and nitrocellulose leads to several possible applications in this direction. Cyclohexanol and methylcyclohexanol are used to a very large extent in the dry-cleaning, dyeing, laundry and textile trades. They are excellent solvents for oils, fats and waxes—probably better solvents for oils than any other solvents on the market—have good wetting-out power and can very easily be combined with soaps to give products having remarkable detergent properties. For dry-cleaning, sextol soaps possess the advantages over the ordinary dry-cleaning soaps of much improved solubility, cleaning power and stability. The high-boiling alcohols are used not only in a wide range of textile trades but in many branches of each. In the woollen trade they are used for scouring raw wool, woollen and worsted pieces and yarns, and in the preparation of spinning oils and hosiery creams, and for assisting levelling and penetration in dyeing. In the cotton trade they are used for scouring cotton goods, cotton-art-silk mixtures, as assistants in kier-boiling, for wetting-out yarns previous to mercerising, in certain finishing operations, and in the preparation of sizes and finishes.

Sextol Soaps

Sextol soaps are being used successfully for silk de-gumming. In the artificial silk trade sextol soaps are good stain-removers and sextol is much used as an accessory in dyeing. Cyclohexanol and methylcyclohexanol and their ketones and esters are practically non-inflammable, non-toxic and non-corrosive, attributes possessed by very few other solvents used in the lacquer, textile and rubber trades. Cyclohexane is a parcularly useful solvent for recrystallisation purposes in the fine chemical industry on account of its sharp boiling-point, pleasant odour and low price and is a valuable solvent for use in the extraction of essential oils. The manufacture of the foregoing solvents has been undertaken in this country by Howards and Sons, Ltd., of Ilford, well-known for over 130 years as makers of fine chemicals.

Solvents for Lacquer and Other Industries

25 Years' Research and Progress

FOR the past quarter of a century, the demand for organic solvents has continuously and rapidly increased, to such a phenomenal extent, that their manufacture now ranks amongst the important industries of the present day.

Exceptional impetus has been given to the production of these materials by the progress of the cellulose lacquer industry in which the quality of the lacquer produced and the resulting finish are influenced to a very high degree by the suitability of the solvents employed. A high standard of purity is required and must be rigidly maintained throughout successive deliveries. The special needs of lacquer makers have resulted in the production of new solvents, which, initially high in cost, have had to be produced at prices which render them capable of employment on a large scale. Many of the problems of lacquer construction have called forth problems for the manufacturers of solvents and plasticisers, and the solution of these has been of inestimable assistance to the cellulose lacquer makers.

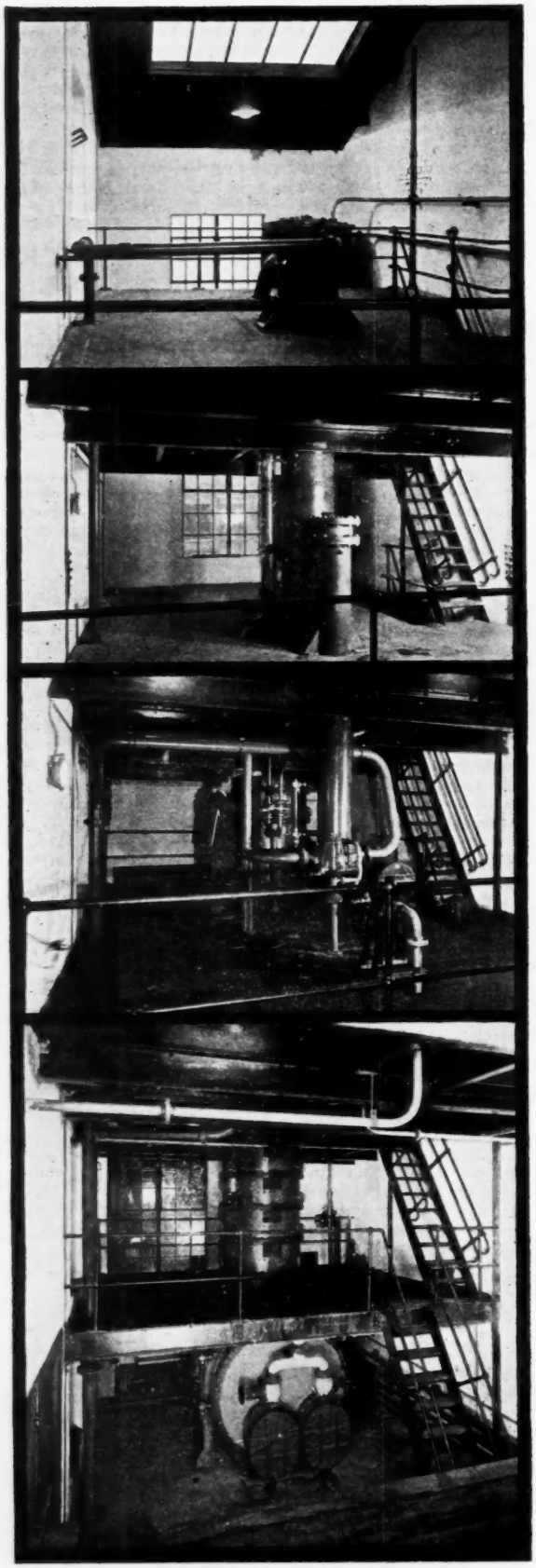
These questions, demanding an infinite amount of painstaking technical research, have been thoroughly investigated by the Chemical Supply Co., Ltd., who celebrate their twenty-fifth anniversary this year. The company was founded in 1905 by Dr. Edgar Neumann, at Plaistow, and in 1913 was established at their present works in Abbey Road, Barking, Essex. About this time the company obtained the services of Mr. E. Likiernik, who developed successively the manufacture of synthetic perfume bases, medicinal chemicals, and plasticisers. Later Mr. S. W. Morris joined the Board on the technical side, followed by Mr. S. G. Settle as Works' Director, and finally by Mr. Rex Campbell, in charge of sales.

The Chemical Supply Co., Ltd., were pioneers in the production of these materials in which they have specialised. Their twenty-five years' life has been spent in continuous research and industrious consideration of the many problems associated with the manufacture of these products upon the commercial scale, in order to satisfy completely the demands of the technicians.

Other important industries, which employ the solvents and plasticisers manufactured by the company, include artificial silk, leather, leather cloth, and the celluloid and plastic industries. The synthetic perfume bases have particular application in the manufacture of soap and other products. Extensive research work upon new processes and the development of additional products proceeds rapidly. The specific requirements of the various industries are carefully studied, so that the company is in a position to give any desired technical assistance in the employment of their products.

Death of Mr. John D. Gillis

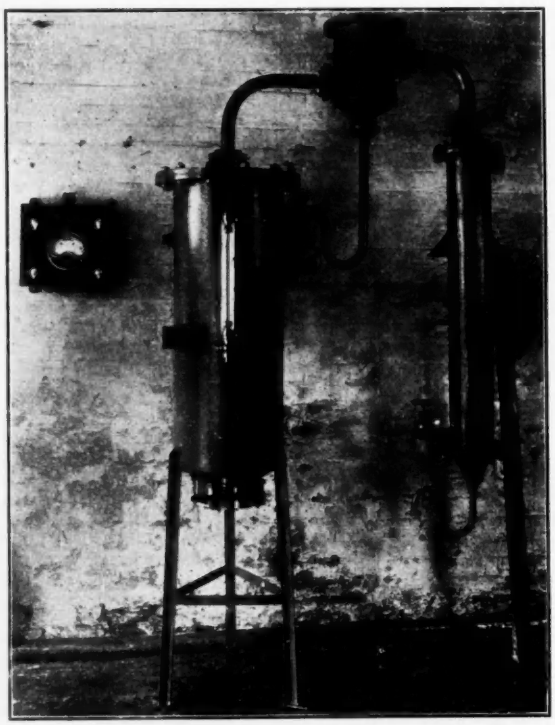
WE regret to announce the sudden death, on Tuesday, June 24, of Mr. John D. Gillis, the vice-chairman and a director of Graesser-Monsanto Chemical Works, Ltd. Although Mr. Gillis had been with the Graesser-Monsanto company for only a short time, his loss will be deeply felt by all who knew him. He was born in Minnesota in 1886. He entered the drug and chemical trade after leaving New York University and had been engaged in this branch ever since. Prior to joining the Monsanto organisation, Mr. Gillis was president of John T. Milliken and Co.



Kestner Plant for Solvents

Variety of Products

THE illustration in the column opposite shows the several floors of a continuous steam heated plant for distillation or fractionation, and is among the large variety of plant for dealing with solvents manufactured by the Kestner Evaporator and Engineering Co., Ltd., 5, Grosvenor Gardens, London. Batch type stills, when dealing with small quantities, are often heated by the Kestner patent oilectric heating system, which forms a very convenient unit, particularly when steam is not available. A small electrically-heated still for solvent recovery purposes is shown below. For obtaining the temperatures required for high boiling point compounds the Kestner patent oil circulation heating system has a number of advantages over the use of steam. In certain cases where no fractionation is required, the Kestner patent film evaporator is more usefully employed than a still, as, for example, in the recovery of solvents in the dry-cleaning industry. For recovery of solvents from solvent-air mixture Gasil brand silica



gel is supplied, which has a very high absorptive capacity. Generally speaking, there is no one standard form of plant for problems involving solvent recovery, etc., as each case must be studied on its own merits, and it is not possible to describe all the various types of plant that this firm construct.

Machinery at Manchester Show

AMONG the exhibitors at the Royal Show at Manchester from July 8—12 will be Peter Brotherhood, Ltd. on stand 88 (machinery-in-motion section) who are showing a 2-cylinder Brotherhood-Ricardo Diesel engine, direct coupled to a Laurence Scott dynamo, the output of which is 50 K.W. (75 B.H.P.) at 750 r.p.m. and working on load. The engine is capable of developing 100 H.P. at a normal speed of 900 r.p.m. and has several novel features of design, the most important being that a single sleeve replaces the usual poppet valve mechanism. On stand 85 in the same section Clarke's Crank and Forge Co., Ltd., are displaying two large oil engine crankshafts, and a collection of smaller oil engine, steam and motor lorry crankshafts. There will also be numerous photographs of machines in which Clarke's Crankshafts and other parts are used and views of the firm's works, illustrating the up-to-date plant and machinery installed.

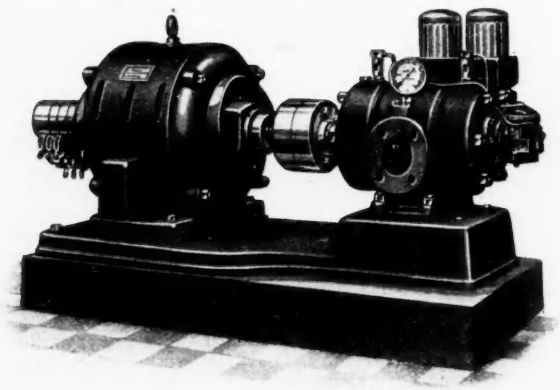
Rotary Air Compressors

A New "Broomwade" Development

BROOM AND WADE, LTD., who have for over 30 years manufactured single stage reciprocating air compressors at High Wycombe, are now making, by arrangement with the patentees, a line of rotary "crescent" type compressors and vacuum pumps, the outstanding feature of which is their extreme simplicity.

The problem of the rotary air compressor design consists chiefly in making provision for preventing wear on the ends of the blades and in the casing, the blades being flung against the casing bore by centrifugal force and rubbing at a high speed. This difficulty has been overcome in the "Broomwade" machine by giving a special shape to the blade tips by which a wedge of oil is continually generated between the blade and the casing and effectually prevents metallic contact. This feature, which is patented in the principal countries in the world, makes it possible to construct a high speed machine without any floating rings, rolling drums or other devices to restrain the blades.

Another feature of the machine is that the stator is bored out to two different diameters, a portion at the bottom being



bored on the same centre as the rotor. This gives a much improved seal between the suction and delivery, and leaves these always separated by at least two blades. The two bores of the casing where they intersect are very carefully "washed into" each other and, except by actual measurement, it is very difficult to detect the two distinct bores.

The stator and end covers, all of which are cast-iron, are provided with ample water jackets. The rotor is a high tensile steel forging made in one piece with the shaft and carried on roller bearings, one bearing being a special lipped type for end location. The blades are hardened and tempered steel carefully finished to the required shape for the formation of the oil film at the tips.

The rectangular cast-iron base on which the machine is mounted is arranged to form an oil tank and is fitted with an oil level rod and strainer. The air pressure from the delivery side of the machine is carried into this base and forces the oil to the plunger type oil pump, which is worm driven from the end of the rotor shaft; this pump delivers the oil through sight feeds. On the smaller sizes no oil pump is fitted, the oil being forced by the air through adjustable sight feeds mounted on the stator. Owing to the heavy load carried by the oil wedge at the tips of the blades, it is very essential that a suitable oil be used and definite recommendations are made for this.

The actual output of each machine is tested by nozzles, and full allowance is made for temperatures. These nozzles have been examined for Broom and Wade by the National Physical Laboratory, and the formula used for calculating the actual air delivered proved to be correct within a very small percentage.

The machines are all designed for standard a.c. current motor speeds, and as they can be direct coupled to squirrel cage motors form a very inexpensive, efficient and compact plant for any use requiring low or medium pressure air or vacuum.

Chemical and Other Trade Publications

Spectrum Analysis

Bulletin No. 2 on "Spectrum Analysis" has just been published by Adam Hilger, Ltd., 24, Rochester Place, Camden Road, London. Since No. 1 of the Bulletin, published in March, 1929, a feature of the development of spectrum analysis has been the large number of publications dealing with quantitative metallurgical analyses, and these are now summarised. Many of the references are to work not yet published, which has been done in the laboratories of Adam Hilger and other laboratories with which the firm is in touch. The Bulletin also includes a bibliography of recent papers on spectrum analysis, notes on the official specifications for lead, copper and zinc, and other information on metallurgical and pharmaceutical applications of spectrum analysis.

Super-Lancashire Boiler Unit

Daniel Adamson and Co., Ltd., of Dukinfield, sole makers and designers of the Patent Super-Lancashire boiler unit, are issuing the official report of the test of a unit recently carried out by the National Boiler and General Insurance Co., Ltd. The average rate of evaporation during the 12 hours was 8,773 lbs. per hour, and the net overall thermal efficiency, based on the net calorific value of the fuel, was found to be 83·31 per cent. The thermal results, the report states, are very good, and the low radiation loss was very apparent. The high efficiency is considered to be due not only to the provision of air heaters, but also to the fact that the boiler is extremely well clothed with non-conducting composition and has no external brickwork flues, while the regulating dampers give the fireman easy control. A thermometer suspended immediately above the superheater registered an average temperature of only 62° F. throughout the test.

Hardness Testing of Metals

A new booklet dealing with the testing of metals and other materials has been issued by Wild-Barfield Electric Furnaces, Ltd., Elecfurn Works, North Road, Holloway, London, distributors of the Vickers Diamond Pyramid hardness testing machine. The generally accepted formula for determining hardness, is represented by Hardness = Load applied / Area of Indentation, and it is upon this formula that the Vickers machine works. The whole theory of this formula and the practical errors, inevitable with some machines, which are overcome by this method of testing, are dealt with as fully as is possible in the booklet. The B.E.S.A. has lately specified the indenter introduced by Vickers and obtainable only on the Vickers machine, as that to be used in the testing of balls for the Brinell test.

Al-Dur-Bra

An attractive brochure has been issued by Charles Clifford and Son, Ltd., Birmingham, dealing with Al-Dur-Bra (an aluminium brass cast by the Durville process), a material highly resistant to corrosion. It finds a use particularly in the form of condenser tubes, but it is procurable also as sheet, rod, wire, stampings and forgings. Its mechanical properties are superior to those of the 70:30 type, being characterised by extremely high ductility, and during annealing and hot working it oxidises or scales very little. The aluminium constituent of Al-dur-bra forms, under service conditions, a very satisfactory protective film which is self healing and, under the action of the cooling water, instantly commences to re-form after abrasion.

Activated Carbon

"Activated Carbon, the Modern Purifier;" is the title of a booklet issued by British Suchar Processes, Ltd., 16, Abbey House, 2, Victoria Street, London, dealing comprehensively with the uses of this material for the removal of colours, odours, and unwanted flavours from solutions and gases by adsorbing the undesired impurities on its surface. The origin and characteristics of activated carbons are explained, together with their many industrial uses and wide fields of development, and finally there is a description of the several varieties of the Nuchar activated carbons of the Industrial Chemical Sales Co., Inc., of New York, and the specific application of each.

Johnson, Matthey and Co., Ltd., 73, Hatton Garden, London, have issued a new general price list of their chemicals.

A folder of Crompton Parkinson, Ltd., Bush House, Aldwych, London, describes and illustrates some Parkinson electric motors and their use in large industrial plants.

D

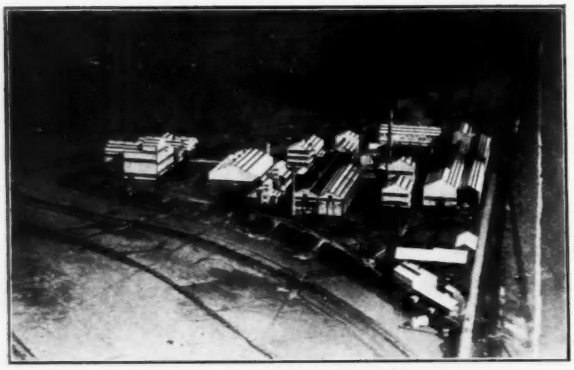
Modern Practice in Heavy Chemical Manufacture

A Tour of the Chemical and Metallurgical Corporation's Works

In this article a detailed account is given of the layout, plant, operations, and products of the Chemical and Metallurgical Corporation's extensive works on the Manchester Ship Canal near Runcorn. Situated in the home of the old alkali industry, the enterprise represents the application to the heavy chemical industry of the newest ideas in construction, engineering, and industrial methods.

THE heavy chemical industry in this country is practically synonymous with the Le Blanc alkali industry, and the history of the Le Blanc process is substantially the history of heavy chemical manufacture. Although the Le Blanc process for alkali manufacture is dead, it was that process which provided the centre round which the manufacture of sulphuric acid, hydrochloric acid, saltcake, Glauber's salts, and other products naturally developed. This group of products, originally bound together by the manufacture of alkali, still remain closely associated as the heavy chemical trade.

The introduction of the industry into England dates from 1823, when James Muspratt introduced the Le Blanc process into the Liverpool district. Development was rapid, so that at a very early date Britain had a world-wide predominance in the industry. For a chemical proocess it held long sway, and it was not till 1873 that its security was first assailed by



AN AERIAL VIEW OF THE WORKS.

the establishment of the first Solvay alkali plant at Northwich. The old Le Blanc process gave ground very slowly at first, but more rapidly as its rival gained strength. It had one important reserve—it also produced hydrochloric acid, an essential article of commerce. Though dwindling, the process survived until exhausted by another line of attack, the electrolytic manufacture of alkali, first introduced commercially into this country in 1895. Electrolytic manufacture of alkali also produces hydrochloric acid as a by-product. The final end of the Le Blanc process coincided roughly with the outbreak of the Great War.

This short sketch is essential to understand aright the position of the English heavy chemical industry in the years following the war. It was an industry formed round a nucleus which had vanished. The works were in the main old-established, evolved and developed over half a century before. Preliminary design and planning had never taken place. They continued to exist because the other products they produced besides Le Blanc alkali remained commercially essential.

Corporation's Unique Programme

The Chemical and Metallurgical Corporation have now carried out a programme which is probably unique. Over one hundred years after the introduction of the heavy chemical industry into England they have erected on a new site a complete new heavy chemical works. At their Astmoor works, there is no tradition, no natural growth, no improvisation, but simply a chemical works deliberately built according to plan and design. On first seeing the works from a distance, the observer is impressed by the difference in general appearance from the traditional chemical works. Perhaps this is due largely to the constructional material employed, which for the bulk of the buildings consists of asbestos sheets on steel framework. Secondly, there is a total absence of fume and smoke.

In designing and building a factory the most difficult mistake to rectify is the placing of the works on the wrong site. The Chemical and Metallurgical Corporation have selected a site one mile to the east of Runcorn. This district is the traditional home of the alkali industry, but the site was not selected on sentimental grounds. As a natural centre for distribution it is obviously good—the industrial regions of Liverpool to the west, Manchester to the east, and Birmingham to the south, are easily reached. The actual site, covering 32½ acres, of which 15 acres are already developed, has a frontage of 1,000 yards on the Manchester Ship Canal, with a private wharf. Apart from the transport facilities, the Ship Canal provides a further necessity for a chemical works—an inexhaustible supply of cooling water. On the other side of the works is the broad estuary of the Mersey, which although not called into service for transport, provides another boon to a chemical works; wide open space in perpetuity. Excellent railway facilities are provided by the Manchester Ship Canal Railway, and the company possesses already some 2½ miles of track within its own boundaries. Road transit also plays an important part in the activities of the Corporation.

The layout of the works is clearly shown from the aerial view we publish. As would be expected in a new works, it follows the American system of block planning of towns. The roads intersect at right angles, running approximately east to west and north to south. The rail tracks run entirely east to west, and each plant is built on a block giving rail facilities on two sides, and road facilities in most cases on three sides. In many cases the rail tracks run inside the manufacturing buildings, the whole layout reducing handling costs to the minimum. In addition to the standard gauge railways, light gauge tracks are laid throughout the works. The whole impression is one of symmetry, neatness and tidiness. The last item is emphasised by the fact that the management have laid the undeveloped areas with turf with neat concrete edging. The grass, too, is actually growing—a vast difference from the alkali industry of the 'forties and 'fifties.

The Key product—Sulphuric Acid

Sulphuric acid is the key product to the heavy chemical industry. As would be expected in a new factory, the contact process has been adopted for the entire production of this product. The raw material at present employed is Scandinavian pyrites. This is stored in a long shed facing the canal. A telpher system runs the whole length of this shed, and the storage capacity is sufficient for 10,000 to 12,000 tons of pyrites. Roughly centrally placed in this shed are the feed bins for the furnaces, which are filled by means of the telpher system. From the bins the ore is discharged into overslung trolleys holding one ton, the trolleys pass over a weighing machine, and are then taken by means of a hoist to the furnace charging platforms. The whole handling costs on the pyrites are under 2d. per ton, a tribute to the efficiency of the layout.

The company has at present six furnaces in operation. All are of the Herreshoff type and are characterised chiefly by their modern design. Three are of Humboldt make and have seven-hearth furnaces, and three, which are believed to be the largest in the country, were supplied by Huntington-Heberlein. These are twelve-hearth furnaces and are over 50 ft. high overall. The sulphur content of the cinders produced often runs between 1 per cent. and 2 per cent. of sulphur. This is remarkably efficient working.

The gas from the furnaces passes by means of flues to an installation of Lodge-Cottrell hot gas treaters, whereby all the dust is electrostatically precipitated. The control of the temperatures on the hot gas treaters is important, and the furnace flues and the treaters themselves are fitted throughout with thermo-couples, all the readings being brought to one central control station.

The gas from the electrostatic purifiers then passes to the sulphuric acid units, of which there are three. All are of the

Grillo type and differ only in detail. It will, therefore, be necessary to describe only one unit.

The gas passes first to the Glover Tower, where it is washed with 40 per cent. sulphuric acid. This serves a double function, to cool the gas and to wash out the bulk of the chlorine and arsenic, both of which are fatal impurities to the catalyst. The gas is then washed with 10° Tw. sulphuric acid, which is efficient in removing more of the chlorine, following which it passes through a battery of four Lodge-Cottrell mist precipitators, which are extremely efficient in removing the mist and the rest of the arsenic and chlorine. As further safeguards for the catalyst, however, the gas is led through a coke filter and given a final wash in the alkali tower, to which small quantities of lime are added periodically. The gas is now absolutely free from impurities and requires only drying before passing to the conversion system. This drying is done by two wash towers in series circulating sulphuric acid 140° Tw. and 168° Tw. respectively. The circulation of the wash liquors is maintained throughout by vertical glandless pumps of special design which give entire satisfaction.

The whole of the purification of the gas is carried on under slight suction, entirely obviating thereby waste and fume. The pure gas is then put through the convertors and absorption system under pressure.

The Convertors

The convertors are of the platinum type and follow the now general system of using two in series, the first working at a high temperature to take advantage of the optimum rate of conversion, and the second at a lower temperature to obtain the optimum degree of conversion. In practice these temperatures may be taken as 600° C. and 475° C. respectively. The conversion system is fitted with two heat interchangers which fulfil the double purpose of cooling the SO_3 produced and heating the inlet SO_2 to the necessary temperature for the reaction. Temperature control is vital for the conversion system and a centralised control station is provided at which all the temperatures throughout the heat interchanger and conversion systems are centralised. In addition are electrical SO_2 estimators and recording pressure and suction instruments. On each unit a 24-hour check test of the purity of the gas is taken, though so far in the operation of the plant only nil results for impurities have been obtained. The gases leaving the convertors, of which 96/97 per cent. of the SO_2 has been converted into SO_3, pass into the absorbers through which 98 per cent. sulphuric acid is circulated. The "make" is bled off continuously and diluted to any strength required. Oleum of 20/23 per cent. is also produced as desired. The absorbtion of the SO_2 is very efficient, and the "exits" to the atmosphere are quite free from fume.

Control is from a well appointed Oleum Laboratory, with every facility for the specialised tests required. Rigorous control is exercised over all deliveries and the product is what one would expect from a modern plant, entirely free from impurities and practically water white in colour. The Corporation, however, manufactures in addition accumulator acid which is entirely water white and fully in accordance with the exacting specification of that trade. The present manufacturing capacity at Runcorn of sulphuric acid is roughly 600 tons per week of 100 per cent. sulphuric acid. The Corporation utilise very large amounts themselves in their own manufacturing operations, but are also to-day marketing sulphuric acid of the highest quality in large quantities.

Hydrochloric Acid Plant

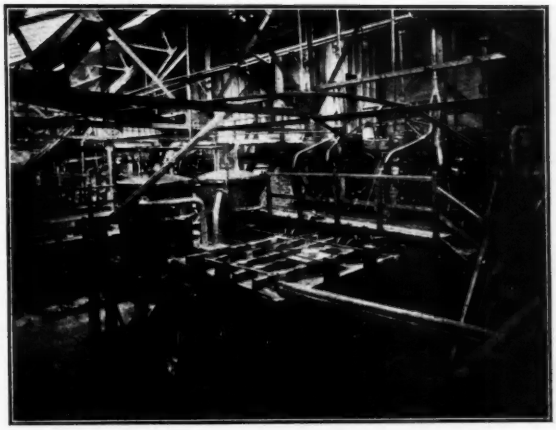
The hydrochloric acid and saltcake plant is thoroughly modern, and would fill with astonishment the early pioneers in the alkali industry. Saltcake making used to be one of the most arduous operations for the workman. Here the manufacture is entirely mechanical.

The layout of the plant is simple and effective. The saltcake and salt stores are housed in one building fitted with telpher handling plant similar to that described for the pyrites stores. One rail track runs through this building, and the trucks of salt are emptied and the saltcake loaded at a nominal cost. Parallel to this building, and adjacent, is the furnace house itself, a building 400 ft. long. Alongside this building runs a second railway track to provide economical fuel handling facilities for the furnaces. The absorption system is housed in a third building again parallel to the stores and plant buildings. The absorber building has been erected sufficiently high to allow a gravity flow of the product to the storage tanks, which are adjacent. By careful design manual handling has been reduced to a minimum and even mechanical handling replaced by gravity flows where possible.

The actual production plant consists of nine furnace units. These are entirely muffled, and fired separately by semi-coke producers. The salt is taken from the stores by a rubber band conveyor and elevated to a storage bin above the charging platform. From the storage bin it discharges to a truck which is filled to a definite weight.

To produce high grade saltcake it is essential that the acid and salt be introduced into the furnace in exactly the correct proportions. At Astmoor the sulphuric acid is taken as the determining factor, and this is taken by gravity feed from a large storage tank into the feed tanks attached to each furnace. From these feed tanks the acid passes into the furnaces by an ingenious compensating device which maintains a constant rate of feed independent of the head of acid in the feed tank itself. For the salt a "solid" worm conveyor is used, which also maintains a constant rate of feed, irrespective of the amount of salt in the feed hopper attached to each furnace and into which the weighed salt is tipped. When once adjusted the process is entirely automatic, one measured batch of acid being used up within a minute or two of one weighed batch of salt, and the only control required by the operator is to refill the feed tank and to empty another batch of salt into the hopper when the previous charge is finished. Control of the amount of production of a furnace is also automatic, each furnace being filled with a four-speed gear which, at the same time, adjusts all the moving parts to the correct relative speeds.

The internal arrangements of the furnace are interesting. The muffle is stoneware and heated both top and bottom. A heavy centre shaft carries four arms, each arm carrying two heavy rabbles which slowly drive the saltcake from the centre to the periphery. The actual passage across the bed of the muffle takes on an average about four hours and the finished saltcake, in which the total impurities measured as salt and free acid are under 2 per cent., is discharged continuously into a water cooled trommel. In this the saltcake is broken up and discharged again continuously as the finished product ready for sale. A negative pressure of about one millimetre of water pressure is maintained on the furnaces, which is sufficient to obviate any fume in the building.



ACID CIRCULATING SYSTEM—SULPHURIC ACID PLANT

The hydrochloric acid gas, which owing to the closed muffle type of the frunace is of high concentration, is taken away from the furnaces by cast iron pipes, which function also as coolers. Before the dew point is reached, these are changed over to earthenware pipes which continue to the absorber house itself. The latter is of most modern design and embodies purification, absorption, and scrubbing plant. The purification is carried out by water-cooled silica coolers and coke filters. The purified gas then passes through Vitreosil absorption units. This plant may not be familiar to all our readers, and has many advantages for other products besides hydrochloric acid. It consists essentially of super-imposed fused silica S bends. Owing to the comparative thinness of

the walls, efficient external water-cooling is possible. Each bend has a lip which holds up a shallow reservoir for surface absorption. The top of each bend is dipped to deflect the stream of gas on to this absorption surface. In addition, in the centre of each bend at the top is a lip which gives rise to a falling curtain of condensates through which the gas stream must pass. This absorption plant is so efficient that, if required, the whole production could be made as 36° Tw. acid, a result impossible with the old hand-worked furnaces and absorption systems.

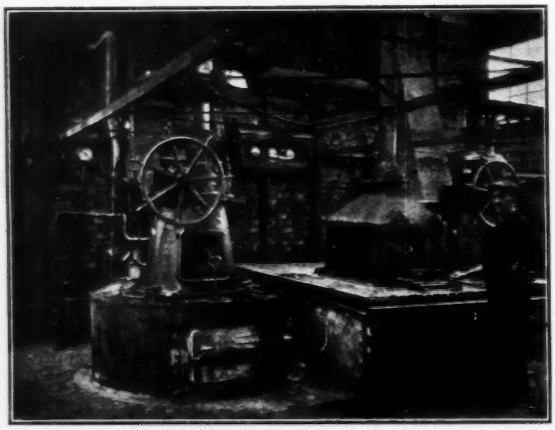
The exit gases from the absorbers pass through a stoneware scrubbing tower fed with water. The whole of the absorption system is under suction provided by means of ebonite-covered steel fans. Rubber is largely used on this plant for the storage tank linings, pipe systems, and the accessory plant in the absorber house. This work was executed by the staff of the company, following very considerable research work carried out by them over many years on the handling and storing of this product.

Glauber's Salt Plant

It would be regarded as strange to find a saltcake plant without a Glauber's salt plant attached, and this is not lacking at Runcorn. The process employed here, as elsewhere, is as old as the product iself, and the chief innovation at Astmoor Works is the adoption of mechanical cradle crystallisers for the manufacture of their entire production. The advantages of the cradle crystalliser are too well known to need discussion here.

Ammonia Liquor and Ammonium Sulphate

These plants are particularly interesting as an adaptation of new methods to an old industry. The introduction on an enormous scale throughout the world of the production of synthetic ammonia and ammonia compounds has not removed the problem of the disposal of the ammoniacal liquor from the gas works. It has broken the virtual monopoly held by the gasworks in the supply of these substances over many generations. At one time practically every gasworks had its own ammonium sulphate plant, which in days gone by was very profitable. The synthetic nitrogen industry has greatly altered the situation. With relatively low prices for the sulphate, in most cases with plants too small for economical and efficient working, the manufacture of sulphate is no longer profitable to the gasworks.



Lead Kettles in the Red Lead Plant

The Chemical and Metallurgical Corporation has planned to meet these new conditions and, at the same time, to solve for the gasworks the problem of the disposal of their liquor. A very large fleet of new 20-ton rail tanks collects the gas liquor over a large area. The location of the factory is very suitable as a collecting centre for the gas liquor from the densely populated and highly industrialised regions of Lancashire and Cheshire.

On arrival at the works the liquor is run direct into one of the battery of four 650-ton storage tanks, specially constructed below ground level. This storage system is at present being greatly increased in capacity to cope with the continually increasing business. From these storage tanks the liquor is pumped to the manufacturing units—300/400 tons per day of gas liquor being disposed of. This is equal to the annual production of liquor of many of the smaller gasworks.

The sulphate plant, supplied by Wiltons, follows the practice adopted throughout the works and is entirely mechanical in design and continuous in operation. Two units are at present in operation, each with a capacity of 15 tons of dry neutral sulphate of ammonia per day. The complete plant consists of three distinct portions, the distillation system, the lining system, and the sulphate units. The ammonia still is of standard and efficient design and was supplied by the Chemical Engineering and Wilton's Patent Furnace Co., Ltd. An important factor is that each section is fitted with a large manhole and that the whole still can be cleansed without dismantling.

Milk of Lime Manufacture

It has long been considered that the liming section of an ammonium sulphate plant was a suitable subject for improvisation. At Astmoor the reverse is the case, the slaking of the lime has been treated as a major operation. The lime plant is housed in a spacious building of its own, and the manufacture of milk of lime is controlled as carefully as any other product. There is thus ensured for the still a constant supply of strong uniform milk of lime, reducing steam consumption to the minimum, and rendering possible almost entire automatic control of the gas liquor and lime flows to the still.

The ammonia gas, after leaving the still, passes through heat interchangers and then into the saturator. The sulphate is periodically removed from the saturator by means of team ejectors into paddle troughs, which maintain a continuous feed on to draining belts. On these belts the sulphate is first drained free of acid liquor, neutralised with ammonium carbonate solution and again drained. The belts discharge continuously into steam heated horizontal driers, which latter again discharge into elevators which lift the finished material into storage bins which are fitted at the bottom with automatic apparatus for filling, weighing and counting the bags. The outstanding feature of the whole plant is that it is entirely continuous and automatic in action, and both units are supervised by one man, the labour costs, therefore, being very low.

In addition to the ammonium sulphate plant, the company possess a very modern pure ammonia liquor plant. Here there is no great departure from standard practice, except in the modern nature of the layout and the plant itself. Gravity flows have been adopted to the maximum possible extent, both for the crude and the pure liquor. This has resulted in the still house being the highest building on the works, but the resultant economy in handling justifies the higher initial cost of the plant. Under modern conditions, quality is the prime essential for all heavy chemicals, and the quality of liquor manufactured at Astmoor reaches a very high standard. The material is water white and free from all impurities originally present in the gas liquor. This result has been obtained by installing purifying plant on a generous scale and by careful control of the manufacturing operations.

Electrical distance thermometers are used throughout the distillation and purifying systems, and recording instruments are centralised in the control laboratory. Control tests are taken throughout the whole 24 hours, and it is by this careful control of an excellent plant that the remarkably high qualities of the products are maintained.

Zinc Chloride Plant

Zinc chloride has been long a usual adjunct of a heavy chemical works. It provides an outlet for hydrochloric acid and is required by many users of other heavy chemicals.

The plant follows the usual practice, and differs chiefly from older plants in the design of the units. The process consists essentially in the solution of secondary zinc material in hydrochloric acid, purification and evaporation of the solution, and final filtration.

The dissolving and purifying vessels are interesting for their relatively large size, being 9 ft. diameter by 12 ft. deep. All are fitted with high speed "torpedo" type agitating gear. Manufacturing economy is achieved by the use of these large scale vessels, especially in purifying, as the technical control necessary is employed on a large batch of material at one time.

For the evaporation, a Vogelbush Rapid evaporator has

been installed and gives extremely good results. The evaporator is homogeneously lead covered, and homogeneous lead coating is employed wherever possible on this plant. Although expensive, the cost is justified by the lower maintenance costs.

Red Lead and Litharge Plant

The operations of the Chemical and Metallurgical Corporation are not limited to the old "standard" list of heavy chemicals, and this survey may close with a reference to the red lead and litharge plants, as these are an example of the extent to which chemical plant to-day has been mechanised.

The plant, which has been designed as a comprehensive whole with a view to the minimising of labour and the welfare of the workers, at present consists of two oxidising kettles, one mechanical litharge furnace, and two mechanical red lead furnaces, together with the necessary packing plant for the two products.

The pigs of lead are fed into a preliminary melting pot, and from this point onwards, until the finished products are in the containers, the material is untouched by hand. The crude oxide obtained from the kettles is transferred by suction to a precipitation chamber, from which it is conveyed entirely by mechanical appliances, either to the red lead or to the litharge furnaces. Neither for the litharge nor the red lead, however, is a continuous system of manufacture employed, the furnaces being worked on a batch system. All three furnaces are muffle type, coke fired, the hearths of the red lead furnaces being nearly 14 ft. in diameter. The litharge furnace is much smaller, and in view of the high temperature required, the agitating gear is water cooled. Extremely high grade products are obtained from these furnaces, and the products pass direct to the packing plants by conveyors and elevators. No grinding is employed, yet the finished products are extremely fine, the red lead particle size being mostly under five microns and all under 30 microns.

In the manufacture of oxide of lead the welfare of the operatives is of paramount importance, and every possible precaution is taken to safeguard this. The entire plant is under suction, and there is no dusting whatever. The whole of the dust collecting system is centralised into two large settlers running the length of the building, from these the settled dust is returned mechanically to the various plants and silos. The very fine dust which does not settle is finally collected in a humidified dust collector which strips the last traces, and the final exits, which discharge outside the building, are entirely free from lead.

Adjoining the red lead building are the Control Laboratory and the washhouses and canteen. In the latter the Home Office Regulations for the control of lead workers have been most liberally interpreted. Separate rooms are provided for washing and dressing, and each workman has a locker in the one room for his working clothes and overalls, and another locker in the other room for his clean clothes. Slipper baths, shower baths, douches for the mouth, a drying room for damp clothes, dining room for meals—all these are provided for and used by the men. Strictest observation of all rules is enforced, and the company have so far had no serious case of lead poisoning among their employees.

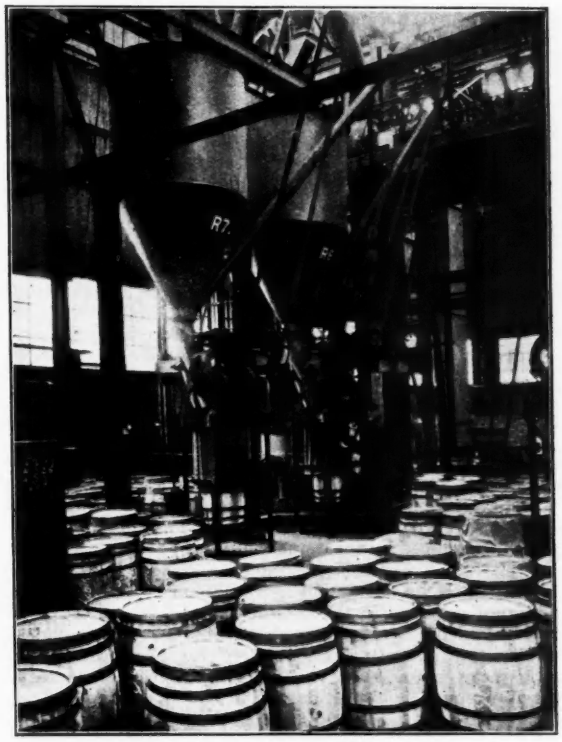
Manufacturing and Sales Control

In connection with the various plants the system of manufacturing control in the various plant control laboratories has been already described. The company have adopted this system of divorcing its manufacturing control from its sales control. Although the initial outlay is higher, this method has the advantage of simplicity in the manufacturing control laboratories. By isolating the tests for one plant, both extreme simplification of the tests and at the same time complete standardisation can be effected. The plant laboratory is really part of the plant.

Sales control is, however, effected entirely by the Central Analytical Laboratory. Here all products are analysed that are purchased and sold. The company state with pride that no product whatever leaves the works without passing through the Central Analytical Laboratory. The system of check is water-tight and complaints as to the quality are virtually non-existent.

Works Offices

The technical management of the works is directed from a fine new block of offices almost in the centre of the works. In this block of buildings are housed on the ground floor the technical officials of the company, the statistical department, and the library. On the first floor are well-equipped drawing offices, and on the third floor is the staff canteen.



Red Lead Packing Plant

As would be expected, the company have on the clerical side, as on the manufacturing side, adopted modern methods in their entirety. For accounting and costing, calculating machines and electrically driven accounting machines are used exclusively. Production records, statements of yields, and laboratory data are furnished daily by the plant officials to the management, and detailed costs are provided by the management to the plant managers at the close of each week. By means of the mechanical system employed there is no delay, the results are available while, in colloquial speech, they are still hot. By this means there is constant co-operation between the works staff and the management to search ever for greater efficiency and reduced costs.

This concludes the present survey of the Astmoor Works. It will have convinced readers that the heavy chemical industry, even in the oldest phases, is far from stagnant. The haphazard ways of the past are fast dying out. Astmoor Works is an example of the progress recorded, a works where layout has been given most careful thought, where the buildings are roomy and well lighted, where mechanical handling appliances are the rule and not the exception, where the technician has taken the place of rule of thumb methods. Most characteristic of all is the centralised control, where the operator reads his instruments and adjusts his conditions accordingly. Probably this also is only a phase. It is not difficult to foresee in many cases the elimination of the human link. To-day, for example, an electrical thermometer tells the operator that conditions are not quite right at a distant part of the plant, and to correct these conditions he adjusts a valve close at hand. It is not difficult to visualise the time when the thermometer itself will operate that valve. Such is really possible with all chemical operations, which are almost entirely functions of temperature, pressure, and quantities in relationship to time. So far mechanical operation has become a reality and the future promises automatic control. One thing, however, is certain. With both of these achieved, the technician will still be searching for other fields to conquer.

By-Product Ammonia—An Economic Aspect.—(II)

By P. Parrish, A.I.C., M.I.Chem.E.

Below we give the conclusion of Mr. Parrish's paper which was among those presented at the World Engineering Conference at Tokio in October–November, 1929. The first instalment appeared last week.

Relative Value of the Two Products, i.e., Gas Liquor and Concentrated Gas Liquor

To see if the concentration of gas liquor is likely to prove economic, schedules must be prepared on a sliding scale basis, showing the charges made, or the prices which can be paid, by chemical works for (*a*) gas liquor, and (*b*) concentrated gas liquor governed (i) by fluctuations in the selling price of sulphate of ammonia for agricultural purposes, as declared by the British Sulphate of Ammonia Federation, Ltd. and (ii) by the strength of the particular product. Naturally, such schedules will vary from time to time, according to the costs of production.

It need hardly be said that the preparation of these schedules concerns the chemical manufacturers who will be called upon to deal with the gas liquor or concentrated gas liquor. More can be paid for concentrated gas liquor if the final products manufactured from it are liquor ammonia, ammonia alum or soda ash produced by the ammonia-soda process.

As, however, markets for liquor ammonia and ammonia alum are circumscribed, and as the quantity of concentrated gas liquor required in the production of soda ash is limited, the method of disposal of concentrated gas liquor must be to chemical manufacturers, largely for the production of sulphate of ammonia. The preparation of the schedules, therefore, must be approached from this point of view

No data have been published regarding the cost of manufacture of sulphate of ammonia from concentrated gas liquor. Calculations show that the possible economy in the distillation of concentrated gas liquor, 15–16 per cent. NH_3, as contrasted with gas liquor of about 2·17 per cent. NH_3, is of the order of 15s. per ton of sulphate of ammonia produced, having a content of 25·71 per cent. NH_3.

The following schedules are typical of the terms and conditions on which it is believed that chemical works would take delivery of (*a*) gas liquor and (*b*) concentrated gas liquor for the manufacture of sulphate of ammonia.

Schedule of Prices for Gas Liquor

The following prices have to be paid by gas undertakings for the removal of gas liquor, loaded by them into the tank wagons of the Chemical Company at the sidings or stations of the gas undertakings.

When the selling price of neutral, dry, sulphate of ammonia, 25½ per cent. NH_3, in bags, for agricultural purposes, is :—						Then the price for gas liquor, per ton, shall be :							
						6·1 to 7·0 oz.	7·1 to 8·0 oz.	8·1 to 9·0 oz.	9·1 to 10·0 oz.	10·1 to 11·0 oz.	11·1 to 12·0 oz.	12·1 to 13·0 oz.	15·1 to 16·0 oz.
£	s.	d.		£	s.	d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
9	0	1	to	9	2	6	9 4	8 9	8 2	7 8	7 2	6 8	6 2	4 8
10	0	1		10	2	6	7 10	7 3	6 8	6 2	5 8	5 2	4 8	3 2
10	2	7		10	5	0	7 8	7 1	6 6	6 0	5 6	5 0	4 6	3 0
10	5	1		10	7	6	7 6	6 11	6 4	5 10	5 4	4 10	4 4	2 10
10	7	7		10	10	0	7 4	6 9	6 2	5 8	5 2	4 8	4 2	2 8
10	10	1		10	12	6	7 2	6 7	6 0	5 6	5 0	4 6	4 0	2 6
10	12	7		10	15	0	7 0	6 5	5 10	5 4	4 10	4 4	3 10	2 4

(a) The above prices are applicable to gas under takings within a radius of 35 miles of the chemical works.

(b) For every 5 miles beyond the said radius, add 6d. per ton for carriage and wagon hire, to the schedule price. For every 5 miles within the radius stated deduct 7d. per ton from the schedule price.

Schedule of Prices for Concentrated Gas Liquor

The following prices shown in Roman letters have to be paid by the Chemical Company to the gas undertakings for the concentrated gas liquor loaded by the gas undertakings at their sidings or stations into the tank wagons of the Chemical Company.

The following prices shown in Italic letters have to be paid by the gas undertakings to the Chemical Company for similar delivery.

When the selling price of neutral, dry, sulphate of ammonia, 25½ per cent. NH_3, in bags, for agricultural purposes, is :						Then the price of concentrated gas liquor, per ton, shall be :				
						60·1 oz. to 62·0 oz.	62·1 oz. to 64·0 oz.	64·1 oz. to 66·0 oz.	64·1 oz. to 68·0 oz.	68·1 oz. to 70·0 oz.
£	s.	d.		£	s.	d.	s. d.	s. d.	s. d.	s. d.
9	0	1	to	9	2	6	*7 10½*	7 8	7 5½	7 3	*7 1*
10	0	1	,,	10	2	6	1 11½	2 3	2 5½	2 9	3 4
10	2	7	,,	10	5	0	3 1	3 5½	3 9	4 1	4 8
10	5	1	,,	10	7	6	4 3½	4 8	5 0½	5 5	6 0
10	7	7	,,	10	10	0	5 6	5 10½	6 4	6 9½	7 4
10	10	1	,,	10	12	6	6 8½	7 1½	7 7½	8 1½	8 8
10	12	7	,,	10	15	0	7 10	8 4½	8 11	9 5½	10 0

(*a*) The above prices are applicable to gas undertakings within a radius of 35 miles of the Chemical Company's works.

(*b*) For every five miles beyond the said radius deduct 7½d. per ton for carriage and wagon hire from the schedule prices. For every five miles within the radius add 6d. per ton to the schedule prices. This only applies to the figures shown in Roman letters.

(*c*) In the case of the italic letters, for every five miles beyond the said radius, add 6d. per ton for carriage and wagon hire to the schedule prices. For every five miles within the said radius deduct 7½d. per ton from the schedule prices.

It is possible now to determine whether the concentration of gas liquor pays. If we take, for example, the case of small gasworks, (*a*) 20 miles, (*b*) 30 miles and (*c*) 40 miles distant from the chemical factory, and assuming the gas undertakings in question dispose of the gas liquor as such, and that they produce it of 10 oz. (2·17 per cent. NH_3) strength, basing on the present market price of £10 13s. per ton for agricultural quality, they will have to pay for the removal of the gas liquor :—

	£	s.	d.
(*a*) 7·27 tons at 3s. 7d.	1	2	6
(*b*) 7·27 tons at 4s. 9d.	1	14	6
(*c*) 7·27 tons at 5s. 10d.	2	2	4

On the other hand, if the gas undertakings in question produce gas liquor of 10 oz. (2·17 per cent. NH_3) strength, and concentrate it to 68·1–70·0 oz. strength, and basing on the assumption that the same market price obtains for sulphate of ammonia, the costs incurred in the respective cases will be :—

	£	s.	d.
(*a*) DR. Cost of concentrating (see cost sheet)	1	19	7
C.R. Less realisation for concentrated gas liquor	0	11	6
Net cost of concentrating	1	8	1
(*b*) DR. Cost of concentrating (see cost sheet)	1	19	7
CR. Less realisation for concentrated gas liquor	0	10	6
Net cost of concentrating	1	9	1
	£	s.	d.
(*c*) DR. Cost of concentrating (see cost sheet)	1	19	7
CR. Less realisation for concentrated gas liquor	0	9	5½
Net cost of concentrating	1	10	1½

Thus, there is an advantage in the cases of (*b*) and (*c*) to the following extent :—

(*b*) Advantage by concentration 5s. 5d. per ton of concentrated gas liquor.

(*c*) Advantage by concentration 12s. 2½d. per ton of concentrated gas liquor.

On the other hand, the concentration of gas liquor is unprofitable in the case of works within 20 miles of the chemical factory when 10 oz. gas liquor is considered, to the extent of 5s. 7d. per ton. Example (*a*) contemplates the worst set of circumstances against the proposition for the concentration of gas liquor, because (i) the gas liquor is tolerably strong, and (ii) the distance from the chemical factory is not very great.

If only 6·1 oz. gas liquor were produced at a works 20 miles distant from the chemical factory, the position would be thus :

	£	s.	d.
Cost of removing 12·13 tons at 3s. 7d.	2	3	6
DR. Cost of concentrating	1	19	7
Plus extra for steam (see table "C"), 7s. 8d.—4s. 4d. ..	0	3	4
	2	2	11
CR. Less realisation for concentrated gas liquor	0	11	6
	£1	11	5

Advantage in favour of concentration :—

£2	3	6
1	11	5
£0	12	1 per ton of concentrated gas liquor produced.

It is seen that where the gas liquor is weak, namely, 6·1 oz. strength, it pays handsomely to concentrate : in point of fact, to the extent of 12s. 1d. per ton of concentrated gas liquor produced.

The question is not infrequently asked : Assuming the market price of sulphate of ammonia declines appreciably, will the concentration of gas liquor still be justified ?

The answer to this question can be given by considering typical cases of small works, (*a*) 20 miles, (*b*) 30 miles, and (*c*) 40 miles distant from the chemical factory.

Assuming 10 oz. (2·17 per cent. NH_3) gas liquor is produced, and the market price for sulphate of ammoniafor agricultural purposes ranges between £9 0s. 1d. and £9 2s. 6d. per ton, then the position is as follows :—

	£	s.	d.
(*a*) Cost of removing 7·27 tons of gas liquor at 5s. 11d. ..	2	3	0
(*b*) Cost of removing 7·27 tons of gas liquor at 7s. 1d. ..	2	11	5
(*c*) Cost of removing 7·27 tons of gas liquor at 9s. 3d. ...	3	7	1

The costs involved in the concentration of the gas liquor are as follow :—

	£	s.	d.
(*a*) DR. Cost of concentration	1	19	7
DR. Cost of removal of concentrated gas liquor	0	5	2½
	2	4	9½
(*b*) DR. Cost of concentration	1	19	7
DR. Cost of removal of concentrated gas liquor	0	6	5½
	2	6	0½
(*c*) DR. Cost of concentration	1	19	7
DR. Cost of removal of concentrated gas liquor	0	7	7
	£2	7	2

Thus it is seen that in case (*a*) it is unprofitable to concentrate, but as the amount to the debit of such operation is only 1s. 9d. per ton of concentrated gas liquor, the dividing line is not a very wide one.

On the other hand, in cases (*b*) and (*c*) it is profitable to concentrate to the extent of 5s. 4½d. per ton and 19s. 11d. per ton of concentrated gas liquor respectively.

Generally speaking, it will be profitable for small works making 10 oz. gas liquor, within a radius of 25 to 30 miles of the nearest chemical factory, to manufacture concentrated gas liquor, or where only 8 oz. strength gas liquor can be produced, it will be profitable for small works within a radius of 20 miles of the nearest chemical factory to manufacture concentrated gas liquor.

If it is profitable for small works to concentrate it is manifestly much more advantageous for medium and large-sized works to adopt this process, having regard to the lesser expenses incurred in the operation. In general, therefore, the reply to the question submitted at the outset of this contribution is that it is profitable for gasworks to adopt a process for the concentration of gas liquor and to supply a product containing 15 per cent. to 16 per cent. of ammonia. It is, however, important that each case should be considered on its merits, and local circumstances should be adequately considered.

If uses can be found for concentrated gas liquor other than for its conversion to sulphate of ammonia, the advantage is likely to be greater than is adumbrated in this contribution.

United Alkali Shares

Terms of Compulsory Acquisition by I.C.I.

MR. JUSTICE FARWELL, in the Chancery Division on Tuesday, had before him a petition by Imperial Chemical Industries, Ltd., asking for the Court's permission to acquire compulsorily the holdings of those shareholders in the United Alkali Co., Ltd., who had refused to accept the terms offered for the acquisition of their shares when the company was merged with Imperial Chemical Industries.

The petition was opposed by a number of ordinary and preference shareholders, the latter including Mr. B. Margerison, a prominent Leeds man.

Mr. H. B. Vaisey, K.C., for the petitioners, said that nine-tenths of the shareholders in the United Alkali Co. had come into the merger. There were 2,825,240 preference and 900,000 ordinary shares of the United Alkali Co., and the dissentients held 3,810 preference and 2,735 ordinary shares. Under the original terms of the merger scheme the offer was :—For every £1 preference share in the United Co. one £1 preference share in I.C.I., and for every six £1 ordinary shares nine £1 ordinary and two 10s. deferred shares in I.C.I. Since the date of that offer, December 15, 1926, conditions had changed and the offer was thought to be too high to make to the dissentients. They were now asked to accept cash for their holdings, viz., 21s. for each preference and 15s. for each ordinary share.

Mr. Thomas Hughes, K.C., who appeared for 982 ordinary shareholders, contended that these terms were unfair and inequitable, and could not be justified on the financial position of the two companies.

Mr. Harold Christie (instructed by Messrs. Simpson and Curtis), who appeared for Mr. Margerison, read an affidavit by him. He said he held 500 preference shares and he opposed the proposed exchange of shares because it deprived him of the valuable rights of participating in the distribution of surplus assets in the event of a winding-up. All the negotiations for the exchange of shares were to the best of his knowledge on the basis that no such participating rights existed. He was willing to sell, but not at the price offered, which was insufficient in view of the rights mentioned and of the company's record. Mr. Christie added that Mr. Margerison had felt aggrieved because he was never told that his shares carried anything beyond the fixed 7 per cent. dividend. The result was that up to March last he was still under the impression that he was not entitled to any further rights.

His lordship said his view at present was that the original offer in 1926 was and still remained a fair basis for the exchange of shares. In his view the proper price to be paid for the outstanding ordinary shares was 45s. each and for the outstanding preference shares 25s. each. He added that it was extremely difficult for anyone in his position to come to a decision, but what he had said was the result of his consideration of all the affidavits and arguments put before him.

Quarry Plant Exhibition at Scarborough

THE fourth exhibition of quarry and building contractors' plant and machinery is to be held at Scarborough from July 2 to 11 next, and in view of the increasing interest that is being taken in tar for roadmaking purposes, the stand of the British Road Tar Association is bound to attract considerable attention. The display will present a comprehensive survey of the use of tar for road making, and will include samples of road tar complying with the British Standard Spe ifications, which have been recently issued. Samples of British stone, in the tarred and untarred state, will be on view, and visitors will have the opportunity of examining the grades of tar used in conjunction with various types of road stone.

Chemical Laboratory Fire

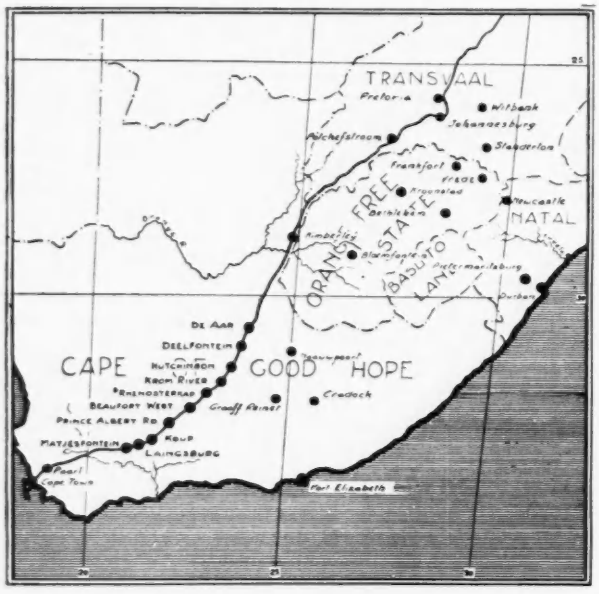
ETHER is believed to have been the cause of a fire which occurred at 6, King Street, West Smithfield, London, the premises of the Wellcome Chemical Research Laboratories, on Thursday, June 19. The firemen were considerably hampered in their work by the suffocating fumes, but with the aid of gas helmets they were able to prevent any serious damage being done to the building. A quantity of ether was destroyed, and the contents of the basement were damaged by fire, smoke and water. Two men, named Leslie Edward Barnett and Thomas Sharp were burned on the hands

Water Softening Plant for Railways

South African Contract for London Firm

FOR some time past the chemists and engineers of the South African Railway and Harbour Board have been studying the question of installing a series of water softening plants for the treatment of locomotive boiler feed on the hard water section of the line which runs through the Karroo Plateau, and an inquiry was issed in January last for a number of installations situate at various stations between De Aar and Matjesfontein.

These plants had to conform to a carefully considered specification which stipulated *inter alia*—(1) that the residual hardness of the softened water should not exceed 5 degrees; (2) that the plant should be of the vertical type, of not less than six hours sedimentation capacity and so arranged that the treated water could gravitate to the locomotive feed tanks; (3) the reagent proportioning apparatus was to be automatic, of robust construction, and designed to deliver a constant proportion of chemicals to raw water at all rates of flow from zero to maximum. Tenderers were warned that big variations in flow might be experienced over short periods;



MAP SHOWING (IN BLOCK TYPE) THE LOCATION OF THE TEN WATER SOFTENING PLANTS, AND (IN ITALICS) OF A NUMBER OF OTHER PATERSON INSTALLATIONS IN SOUTH AFRICA.

(4) automatic cut-off arrangements had to be provided for interrupting the raw water supply to the softeners as soon as the soft water receiving tank was full.

It is now learned that the Paterson Engineering Co., Ltd., of London, through their South African representatives, Blane and Co., Ltd., of Johannesburg have been awarded the entire contract for the installation of ten large vertical water softening plants at the various watering stations on the Karroo section, viz:—

	Gallons per hour.
De Aar	16,000
Deelfontein	10,000
Hutchinson	12,000
Krom River	10,000
Rhenosterkop	8,000
Beaufort West	10,000
Prince Albert Road	8,000
Koup	8,000
Laingsburg	10,000
Matjesfontein	8,000

This contract, perhaps the most important ever placed in this country for a group of water softening plants for railway installations, was secured in the face of keen international competition and after the South African Railways and Harbour Board had had experience of similar Paterson water softening plants installed five years ago at Pretoria and having a capacity of 10,000 gallons per hour.

Other recent contracts for Paterson water purification plant placed by the South African Railways include:—water softeners of 10,000 gallons per hour for Naauwpoort; an oil eliminator of 3,000 gallons hourly capacity for Greyville; chlorinating plant of 30,000 g.p. hour at Walfisch Bay; and three water hardening plants for stations in the Cape Town district.

The Avery Bicentenary

Scales for Laboratory Use

THE recent announcement in these columns of the bicentenary of W. and T. Avery, Ltd., the well-known weighing machine and scale manufacturers, in connection with which a visit will be paid to the works on Tuesday, draws attention to the wide range of instruments of interest to the world of industrial and engineering chemistry manufactured by this firm. Messrs. Avery are probably the largest manufacturers of weighing and testing appliances in the world, and their products cover the needs of practically every kind of trade and industry. Avery visible indicating scales are used in research and industrial laboratories for such purposes as weighing specimens in timber, testing, weighing synthetic resins for Bakelite mouldings, and in concrete moisture tests, cotton bolls, and rovings; also for yarn blending and estimating the denier of silk, and for many other purposes. For predetermined load weighing, charts are regularly supplied graduated "light" and "heavy" from a central zero, so that excess or deficiency from the correct weight is indicated directly. A relatively high degree of accuracy is possible with these scales, the charts in some cases being marked by divisions as small as 0·01 gramme.

These scales are made in many different forms. Fine balances of the even-arm beam type have a capacity of 500 grammes, some with the chart at the top of the housing, others with the chart fixed at the base beneath an adjustable magnifying lens. Heavy capacity balances of similar construction have a standard capacity of 5 kg. Bench scales with a capacity of 10 kg. are designed with the Beranger lever system, and have special fittings for carrying bottles, phials, etc. There are platform scales with a capacity of as much as 1,000 kg., portable platform scales, with a capacity up to 750 kg., and a somewhat unusual type of hanging scale, carrying 60 kg. Some types have a movable indicator and a stationary chart, whilst others are built on the revolving dial system, with a fixed indicator.

Rapid Gravitometer

A probably unique instrument is the Avery rapid gravitometer, designed for ascertaining rapidly and accurately the specific gravity of solids. No weights or arithmetical calculations are necessary, and the only number which requires to be read is that which expresseses the specific gravity of the body under examination. A determination can be made in 30 seconds. To make a determination, the body is suspended from a hook at the end of an extremely sensitive spring and by turning a milled knob, a pointer attached to an inclined graduated bar is brought into coincidence with the pointer of the spring resistant, now indicating the weight of the body in air. A beaker containing water is raised into position by turning another knurled knob at the base of the instrument. The pointer of the spring resistant then indicates the weight of the body in water. To this indication a pointer operated by a third knob is made to coincide. The specific gravity can then be read directly on the graduated bar at the point of intersection by the upper member of a parallel rule. This instrument may have a graduated scale adapted for comparatively light substances such as rubber, or additional springs can be fitted for dealing with heavy samples. Modifications of the instrument are manufactured for the determination of the specific gravity of liquids, solids of specific gravity below 1·0, and metals of low specific gravity.

Many of the Avery laboratory balances can be fitted with charts graduated for costing purposes in weights per dozen, per gross, and the like; or they may be graduated for counting purposes, showing, for instance, the number per pound. These notes indicate the firm's close association with the chemical and allied industries.

From Week to Week

SIR WILLIAM JACKSON POPE, Professor of Chemistry at Cambridge, has been awarded the degree of Doctor Honoris Causa of Brussels University.

MR. J. VAUGHAN RUSSELL, who for the past three years has been secretary of Charles Tennant and Co., Ltd., chemical manufacturers and merchants of Glasgow, has been appointed a director of the firm.

A £200,000 UNDERTAKING for the production of oil from coal is shortly being started in the Transvaal by an English firm, which is completing its own arrangements without Government assistance.

DR. W. SINGLETON, at one time assistant public analyst at Birmingham, and for the past ten years chief chemist at the research laboratories of the General Electric Co., has been appointed Director of Research to the Associated Lead Manufacturers.

FIRE BROKE OUT on Friday, June 20, at the premises of Bituminous Compositions, Ltd., at Grimsby, owing to a leakage of bitumen from a tank. Firemen fought the blaze with chemicals and sand for three hours and girl employees assisted them to roll drums of inflammable compositions away from the flames.

DRUGS worth more than £100,000 to illicit dealers were seized on board an English liner at Marseilles last week. A number of suspicious packages were examined, and under a covering of carpets, dried fruit and gums, were found hundreds of soldered tins containing in all more than a ton of heroin, cocaine and morphine.

A PROLONGED STRIKE is expected in the Alsatian potash industry, where a large proportion of the workers in the pits under the control of the State and those belonging to the Kali-Saint-Thérése Company have come out as the result of the companies' refusal of their demand for an increase of the base wages by 5 francs a day. Fortunately the dead season is now in course and shipments will not be resumed till September, when it is hoped an agreement will have been reached.

NEGOTIATIONS are in progress, it is announced, for a merger of Scottish and Australian distillery interests. At the annual meeting of the Distillers Co., Ltd., last July, the chairman (Mr. W. H. Ross) referred to the important and profitable business done by their associated companies in Australia, where the Distillers Co. has important interests. The last report referred to the opening of a new distillery at Geelong, built as a joint investment with a group of Australian shareholders.

LORD MELCHETT last week travelled by air to Ostend, where he presided over a meeting of European Synthetic nitrogen manufacturers. Dr. Bosch, of the I.G. Farbenindustrie, was among those present and it is understood that agreement was reached in principle as to the necessity of working in close collaboration. This, it is believed, may be the beginning of a wider agreement between British and German producers to rationalise the markets for nitrogenous products.

A VERDICT of "Accidental Death" was returned at the inquest at Stockton on Friday, June 20, on William Owen (53), of 16, Central Avenue, Billingham, who died from injuries received in a tank explosion at the Synthetic Ammonia and Nitrates Works. The deputy works manager of the Alkali Division said in his opinion the primary cause of the accident was water getting into the tank, causing a rise of pressure, but there was no direct evidence to show what had really happened.

THE BRITISH INDUSTRIES FAIR (1931), it is announced, will open as usual in London and Birmingham on Monday, February 16, and close on Friday, February 27, but the hours will be from 9.30 a.m. to 7.30 p.m., half an hour earlier in each case than previous years. In a letter to manufacturers, Sir Edward Crowe, the Comptroller-General, Department of Overseas Trade, points out that the Government have again made a grant of £25,000 for advertising the fair, and the services of the trade commissioners, the commercial diplomatic officers, and the consular services will be available for making the fair known to trade buyers in all parts of the world.

THE UNIVERSITY OF LONDON has conferred the degree of D.Sc. (Engineering) on Dr. Burrows Moore, head of the research section of the Thermal Syndicate, Ltd.

THREE THOUSAND WORKING DAYS were lost in Great Britain and Northern Ireland as the result of two disputes in the chemical industry involving 400 workpeople during the first five months of 1930.

A FINE OF £5, or 25 days' imprisonment, was imposed by the Derby magistrates last week on Michael Farnsworth, chemical manufacturer, of Lumsdale, Matlock, for obtaining food by false pretences from a Derby landlady.

RECENT WILLS include Mr. Alfred Charles Marshall (80), the Grove, Boltons, South Kensington, interested in the Morgan Crucible Co., Ltd. (net personalty £223,874), £223,975; Mr. Norman Peter Stewart, Whitecraigs, N.B., chemical merchant (personal estate in Great Britain), £7,254.

UNIVERSITY NEWS.—*Glasgow:* Honorary degrees of Doctor of Laws have been conferred on Professor Julius Berend Cohen, Emeritus Professor of Organic Chemistry in the University of Leeds, and Sir Ernest Rutherford, O.M., Cavendish Professor of Experimental Physics at Cambridge.

MEMBERS of Sheffield University Chemical Society last week visited the new coke ovens and by-product plant of the Thorncliffe Coal Distillation, Ltd., at Smithy Wood, and made a tour of the works. Among those present were Professor Douglas Hay and Major Richard Miles, of Newton, Chambers and Co., Ltd., and Mr. G. J. Greenfield, manager of the Smithy Wood Gas and Coke Plant.

THE PROTOCOL, signed at Geneva on June 17, 1925, for the prohibition of the use in war of asphyxiating gases and of bacteriological methods of warfare has, announces the *Board of Trade Journal*, been ratified by His Majesty (on behalf of the United Kingdom, Canada, India, and all parts of the British Empire not separate members of the League of Nations), as well as by Denmark and Sweden; and it has been acceded to 'on behalf of Australia, New Zealand and the Union of South Africa.

CHANGES OF ADDRESS.—F. W. Bridges and Sons, Ltd., organisers of the Shipping, Engineering and Machinery Exhibition at Olympia and the Laundry and Allied Trades Exhibition at the Royal Agricultural Hall, have transferred their offices from Southampton Row to Grand Buildings, Trafalgar Square, London. Their new telephone number is Regent 6861-2. Ebenezer King, Ltd., have since June 24 moved to new and larger premises at 23, Whitefriars Street, London.

HITHERTO UNPUBLISHED EXTRACTS from Michael Faraday's diary were read by Sir William Bragg to an audience of 400 scientists at Cornell University on Friday, June 23. He revealed that August 29, 1931, a hundred years from the date entered by Faraday in the diary reporting his first successful experiment on the relation of electricity and magnetism, which was in effect the first dynamo, is to be celebrated as the centenary of the dynamo. On that date the diary would be published in full in six volumes.

THE BRADFORD DYERS' ASSOCIATION, LTD., held their Works Council inter-branch ambulance and fire brigade shield contests at Thornbury, Bradford, on Saturday last. Eight teams entered for the ambulance section, which resulted as follows: 1, Greetland Dyeing Co.; 2, Ripley East; 3, R. Clay, Ltd. In the fire brigade section, twelve teams entered, and the result was: 1, Greenbottom Dyeing Co., Ltd., 42⅝ secs.; 2, Stockbridge Finishing Co., Ltd., 48 secs.; 3, Aykroyd and Grandage, Ltd., 52 secs.

Obituary

MR. SAMUEL BOWEN BOWEN, Swansea, former owner of a Llanelly chemical works.

MR. F. ANDERSON, Widnes, for forty years with the United Alkali Company, on June 17 aged 67.

MR. JAMES TENNANT, late with Charles Tennant and Co., Ltd., Glasgow, on June 21, aged 90.

Mr. F. STIRLING NEWALL, chairman of Turner and Newall, Ltd., and managing director of the Washington Chemical Co., Ltd., on June 24, aged 75.

MR. DAVID WATT, Nottingham, manager of the wet drug department of Boots Pure Drug Co., and the third oldest employee of the firm, on June 15.

Patent Literature

The following information is prepared from published Patent Specifications and from the Illustrated Official Journal (Patents) by permission of the Controller to H.M. Stationery Office. Printed copies of full Patent Specifications accepted may be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, at 1s. each.

Abstracts of Accepted Specifications

328,128. CALCIUM OXIDE AND SULPHUR DIOXIDE. A. Fleck, Norton Hall, The Green, Norton-on-Tees, and Imperial Chemical Industries, Ltd., Millbank, London. Application date, May 9, 1929.

Gypsum or anhydrite is treated in a rotary kiln with coal or producer gas and insufficient air for complete combustion. Lime is obtained and the escaping gases contain sulphur dioxide.

328,156. NITRIC ACID. J. Y. Johnson, London. From I.G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany. Application date, June 14, 1929.

Concentrated nitric acid is treated with oxides, hydroxides, carbonates, nitrates, etc. of di- or tri-valent metals which form nitrates soluble in concentrated nitric acid. Sulphuric acid in the nitric acid is thus precipitated as insoluble sulphates. Magnesium, aluminium, iron, zinc, manganese, and nickel may be used for this purpose.

328,190. ESTERS, SYNTHETIC RESINS. J. Y. Johnson, London. From I.G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany. Application date, October 20, 1928.

Products of a resinous, waxy, or balsamic nature are obtained by the treatment of resinic acids, or natural resins or gums containing them, or artificial resins containing free carboxylic acids, with alkylene monoxides, *e.g.*, ethylene oxide or propylene oxide, at raised temperatures, *e.g.*, 60–100° C., and preferably under increased pressure. Suitable resinic acids are those contained in or separated from colophony, copals, or shellac. In all cases the products may be hardened, *e.g.*, by heating *in vacuo*. According to the Provisional Specification, the alkylene oxides may be replaced by derivatives thereof such as the corresponding halogen hydrins, and carboxylic acids, *e.g.*, phthalic, succinic, citric, tartaric, sebacic, palmitic, and stearic acids in addition to the resinic acids, and acid-reacting natural or artificial resins or salts thereof, may be treated with these reagents.

328,210. AROMATIC AMINES. A. Carpmael, London. From I.G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany. Application date, January 18, 1929.

To separate the constituents of mixtures of aromatic amines, a current of dry hydrogen halide gas is passed into the mixture or into a solution thereof in an indifferent solvent, the precipitated hydrohalide of the strongest base present is filtered off, and the process is repeated, if necessary, to separate the hydrohalides of the successive constituents in order of basicity Specified solvents are benzene, toluene, chlorobenzene, *o*-dichlorobenzene, tetrahydronaphthalene, and benzine.

328,211. ALKALI FLUORIDES. A. Carpmael, London. From I.G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany. Application date, January 18, 1929.

Alkali fluorides and bifluorides are obtained by the action of gaseous hydrofluoric acid in excess on the corresponding chlorides. The course of the reaction at various temperatures is discussed in the Specification with special reference to the production of the fluorides and bifluorides of sodium and potassium.

328,212. SYNTHETIC DRUGS. A. Carpmael, London. From I.G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany. Application date, January 18, 1929.

Double salts of 3 : 6-diamino-10-alkylacridinium bases with 3 : 6–diamono-acridine, which, if sufficiently soluble in water, have bactericidal value, are obtained by one of the following methods :—(1) interaction of a mono-salt of each base in a solvent or suspending agent, (2) combination of an acid quaternary salt with 3 : 6-diaminoacridine, (3) combination of the quaternary base with an acid salt of 3 : 6-diamino-acridine, (4) combination of the acid salts of both bases or of one acid and one mono-salt, and removal of the excess of acid by addition of a base, (5) interaction of both bases or of one base and one mono-salt with addition of the necessary amount of acid.

328,220. DYE INTERMEDIATES. Major and Co., Ltd., 12, Norfolk Street, Strand, London, and H. H. Hinchcliffe, Dyeworks, Sculcoates, Hull. Application date, January 19, 1929.

Aromatic hydroxy sulphonic acids are obtained by treating with concentrated sulphuric acid, the products of condensation of phenol, *o*-cresol, *p*-cresol, α-and β-naphthols with aromatic sulphonyl chlorides, and diluting the sulphonated products with water. Examples are given of the production of 1-hydroxybenzene-4-sulphonic acid and 1-hydroxynaphthalene-4-sulphonic acid.

328,241. SILICA. A. P. Okatoff, 32, Ropschinskaja, Leningrad, Russia. Application date, October 23, 1928.

Silica gel is obtained by a process comprising the steps of (1) adding sodium silicate solution to hydrochloric acid in such quantity that the mixture remains acid, (2) allowing the mixture to stand until the jelly first formed becomes covered with liquid and begins to break up, (3) breaking the jelly to pieces and treating it with a solution of an alkali or ammonium salt of sulphuric, phosphoric, or other dibasic acid containing ammonia in quantity insufficient to neutralise all the free acid present, (4) washing and drying at 150–200° C.

328,248. DYES. A. Carpmael, London. From I.G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany. Application date, January 12, 1929.

Vat dyes of the anthraquinone series are obtained by the action of sulphuric acid at a low temperature on 1 : 1-^{1}dianthraquinonylamine derivatives containing a thioxanthone ring in the 3 : 4-position and, in addition, either an acridone in the 3^1 : 4^1–position or at least one acidylamino group in the anthraquinone nucleus which does not carry the thioxanthone ring. The condensation products may be subsequently oxidised, when carbazolisation apparently results. Thus, the condensation product of 4-aminoanthraquinone-thioxanthone and 1-benzoylamino-5-chloranthraquinone is treated with sulphuric acid and subsequently with sodium nitrite to obtain a carbazole derivative which dyes blackish-brown shades.

328,272. POTASSIUM NITRATE; AMMONIA. J. Y. Johnson, London. From I.G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany. Application date, December 12, 1928.

The yield of potassium nitrate obtained by interaction of calcium nitrate with potassium chloride is increased by adding ammonia to the solution before the separation of the potassium nitrate. A further addition of ammonia is preferably made after such separation to precipitate the calcium chloride as $CaCl_2$, $6NH_3$, thus enabling a further working up of the liquor to obtain more potassium nitrate. On heating the precipitate, calcium chloride and ammonia are obtained, thus enabling the recovery of pure ammonia from gaseous mixtures containing it, if such mixtures are used in the process.

328,276. PURIFYING FATTY OILS. J. Y. Johnson, London. From I.G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany. Application date, December 24, 1928.

Simultaneous bleaching and deacidifying of fats and fatty oils are effected by admixture with a finely divided adsorption agent, such as adsorption carbon, and heating of the mixture at reduced pressure with a stream of inert gas bearing a liquid, *e.g.*, water, benzene, or alcohol, in the state of a mist as described in Specifications 213,267 (see THE CHEMICAL AGE, Vol. X, p. 578) and 235,792. In an example sesamum oil is mixed with fuller's earth, the mixture is treated with wet saturated steam, and the fuller's earth is removed by filtration.

328,277. EXPLOSIVES. D. T. Jones, 89, Caledonia Road, and F. J. Moore, Maythorne, Ardrossan Road, Saltcoats, Ayrshire, and Imperial Chemical Industries, Ltd., Millbank, London. Application date, January 15, 1929.

Basic, normal, or acid lead salts of 2-nitroresorcinol, singly or in admixture, are employed for charging percussion caps and percussion or friction primers. In the manufacture of such salts conditions of temperature, concentration of solu-

tions, and rate of addition of reagents are so chosen that a relatively dense and good running product is obtained. Suitable conditions are indicated in a number of examples.

328,291. DYES. O. Y. Imray, London. From I.G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany. Application date, January 18, 1929.

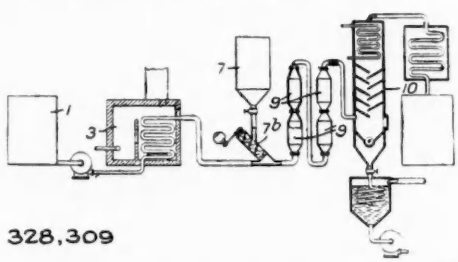
1 : 2-Naphthophenazine sulphonic acids substituted in the 8-position by an acidylamino group are obtained by condensing a 1 : 2-diamine of the benzene series with a 1 : 2-naphthoquinonesulphonic acid substituted in the 8-position by an acidylamino group. The product may be saponified to remove the acidyl group, and the sulphonic group may be split off by heating with strong sulphuric acid. The resulting 8-amino-1 : 2-naphthophenazine may then be acidylated. The 8-aroylamino-and 8-amino-1 : 2-naphthophenazine sulphonic acids are acid wool dyes, the 8-amino-1 : 2-naphthophenazines are dyestuffs for cellulose acetate, and the 8-acidylamino-1 : 2-naphthophenazines are fat-soluble dyestuffs.

328,292. DYES AND LAKES. Major and Co., Ltd., 12, Norfolk Street, Strand, London, and H. H. Hinchcliffe and W. J. Darby, Dyeworks, Sculcoates, Hull. Application date, January 19, 1929.

Monoazo dyes derived from 2 : 3-oxynaphthoic acid are condensed with aromatic sulphonyl chlorides in presence of alkali. The products are suitable for the production of lakes. In examples the dyestuffs 1 : 4-toluidine-3-sulphonic acid→2 : 3-oxynaphthoic acid and 2-chloro-5-toluidine-4-sulphonic acid →2 : 3-oxynaphthoic acid are each treated with *p*-toluenesulphonic chloride (2 mols.) in presence of caustic soda.

328,309. PURIFYING HYDROCARBON DISTILLATES. R. C. Osterstrom, 35, East Wacker Drive, Chicago, U.S.A. Application date, October 9, 1928.

Unsaturated colouring and gum-forming constituents are removed from cracked hydrocarbon oils by introducing into a stream of the oil or of its vapour an adsorbent such as fuller's earth, charcoal, bone ash, acid-treated clay, silica gel,



328,309

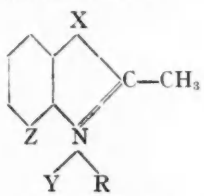
Bentonite, or diatomaceous earth, mixed if desired with lead oxide to remove sulphur. Polymerisation takes place in the vapour phase under the influence of heat generated by the reaction without cracking, and the mixture is finally discharged into an enlarged unheated separating zone to remove lighter oils from polymerised heavy oils and adsorbent. Oil from a reservoir 1 passes through a heater 3 and adsorbent from a reservoir 7 is continuously introduced by a screw or pump 7*b*. The mixture then passes to reaction chambers 9 and thence to a separator 10. Oil vapours are taken at a regulated temperature from the top of the separator, while the polymerised oils and the adsorbent are drawn off at the bottom. Alternatively, the adsorbent may be introduced before the oil reaches the heater, a pressure valve being so arranged that vaporisation occurs only at the outlet from the heater.

328,334. DYES. J. Y. Johnson, London. From I.G. Farbenindustrie Akt.-Ges., Frankfort-on-Main, Germany. Application date, November 27, 1928. Divided on and addition to 307,328 (see THE CHEMICAL AGE, Vol. XX, p. 359).

Dibenzanthrones and isodibenzanthrones containing negative substituents are condensed with nitrogenous organic compounds, capable of being vatted, which contain at least one reactive hydrogen atom connected to a nitrogen atom, condensation with aminoanthraquinones and derivatives thereof being excluded. The condensation is preferably effected in solvents or diluents of high boiling point in presence of catalysts and acid-fixing agents. Specified nitrogenous organic compounds are monoaminoanthanthrone, monoaminopyranthrone, 4-amino-1 : 1^1-dianthrimidocarbazole and its 5-methoxy derivative, 4-aminoanthraquinone-2 : 1-benzacridone, and amino derivatives of *ms*-benzdianthrone, allo-*ms*-naphthodianthrone, and benzanthrone-pyrazolanthrone.

328,357. DYES. R. Kuhn, 10, Moussonstrasse, and A. Winterstein, 4, Physikstrasse, Zurich, Switzerland. Application date, February 13, 1929.

Cyclammonium polymethine dyes are obtained by condensation of formic acid or a formate with a methylene base of a cyclic ammonium salt carrying an active methyl group in α-or δ-position. The methylene base may be substituted by a salt thereof with an organic acid. 7 : 7^1—Substituted polymethine dyestuffs which are not obtainable by known methods may thus be prepared. As an example formic acid or formates may be condensed with the methylene bases of compounds of the general formula—



in which X is a divalent residue such as $—CH_2—$, —S—, or —CH=CH—, Y is an acid radicle, Z is a substituent such as methyl, halogen, or alkoxy, and R is an alkyl group.

328,362. ALLOYS. International Nickel Co. and P. D. Merica, 67, Wall Street, New York, U.S.A. Application date, May 16, 1929.

A malleable nickel alloy contains 10–20 per cent. of chromium, 0·1–10 per cent. of iron, and either 0·01–5 per cent. of aluminium, or 0·03–0·15 per cent. of magnesium, or 0·03–0·15 per cent. of calcium. Manganese, silicon and carbon may be present as impurities. A deoxidation of the molten alloy may be effected with silicon and manganese sufficient in amount to allow the alloy to retain 0·05–1 per cent. of silicon and 0·1–3 per cent. of manganese.

328,418. AMINES. Imperial Chemical Industries, Ltd., Millbank, London, and L. J. Allchin, Crumpsall Vale Chemical Works, Blackley, Manchester. Application date, April 11, 1929.

The mixture of isomeric xylidines resulting from the reduction of crude nitroxylenes is subjected to the usual processes for removal of the bulk of the *p*- and *asym-m*-xylidines, and *vic-m*-xylidine is separated from the residual mixture by dissolving in moderately concentrated hydrochloric acid, adding to the hot solution the chloride of a metal of group II (b) of the periodic system, *e.g.*, zinc chloride, cooling, and filtering the crystalline precipitate. The latter is then treated with alkali and the base is removed by distillation in steam.

328,432.—GLASS MANUFACTURE. C. G. Brooks, 140, King's Cross Road, London. Application date, April 22, 1929.

A borosilicate glass resistant to chemical and thermal changes is made by melting a batch containing less than 70 per cent. of silica, more than 6 per cent. of alumina, and a moderate amount of boric oxide, together with at least three oxides of bivalent metals, *e.g.*, magnesium, zinc, calcium, or barium, and at least three oxides of monovalent metals, *e.g.*, lithium, sodium, or potassium.

[NOTE.—Abstracts of the following specifications, which are now accepted, appeared in THE CHEMICAL AGE when they became open to inspection under the International Convention :—304,727 (Schering-Kahlbaum Akt.-Ges.), relating to alkylene-substituted phenols, see Vol. XX, p. 320 ; 306,492 (I.G. Farbenindustrie Akt.-Ges.), relating to mercapto benzothiazoles, see Vol. XX, p. 432 ; 306,843 (I.G. Farbenindustrie Akt.-Ges), relating to azo dyestuffs containing chromium, see Vol. XX, p. 432 ; 307,345 (W. Bachmann), relating to pure aluminium compounds suitable for the production of aluminium, see Vol. XX, p. 454 ; 310,479 (F. C. Palazzo), relating to triple superphosphates, see Vol. XX, p. 620 ; 310,964, relating to production of acetylene dichloride of low boiling point from acetylene and chlorine, see Vol. XXI, p. 10 ; 311,661 (Soc. of Chemical Industry in Basle), relating to intermediate products of the benzanthrone series and dyestuffs therefrom, see Vol.

XXI, p. 58; 313,409 (Vereinigte Aluminiumwerke Akt.-Ges.), relating to aluminium oxide, see Vol. XXI, p. 156; 313,927 (I.G. Farbenindustrie Akt.-Ges.), relating to yellow monoazo dyestuffs, see Vol. XXI, p. 178; 314,028 (I.G. Farbenindustrie Akt.-Ges.), relating to orthoaminocarboxylic acid esters of the anthraquinone series, see Vol. XXI, p. 179; 314,526 (A. Karl) relating to zirconium oxide, see Vol. XXI, p. 203; 317,437 and 319,727 (Mathieson Alkali Works), relating to hypochlorite compositions, see Vol. XXI, pp. 342 and 552.

Specifications Accepted with Date of Application

306,116. Wetting, cleansing, emulsifying, and dispersing agents and preparations containing the same, Manufacture and production of. I.G. Farbenindustrie Akt.-Ges. February 17, 1928.

307,300. Automatically regulating the concentration of materials suspended in liquids, Process and apparatus for. T. Kalle. March 3, 1928.

307,304. Aminoalcohols, Manufacture of. I.G. Farbenindustrie Akt.-Ges. March 2, 1928.

307,305. Aminoalkyl compounds, Manufacture of. I.G. Farbenindustrie Akt.-Ges. March 2, 1928.

307,307. Amino-substituted tertiary alcohols, Manufacture of. I.G. Farbenindustrie Akt.-Ges. March 2, 1928.

307,308. Rubber-like masses, Manufacture of. I.G. Farbenindustrie Akt.-Ges. March 3, 1928.

314,052. Refining benzene. Soc. du Gaz de Paris. June 23, 1928. Addition to 307,935.

315,700. Di-ammonium phosphate. Production of. Federal Phosphorus Co. July 16, 1928.

316,858. Hardening of condensation products from phenols and aldehydes. F. Schmidt. August 3, 1928. Addition to 304,648.

330,215. Dyestuff intermediates. J. Thomas, D. A. W. Fairweather, and Scottish Dyes, Ltd. November 27, 1928.

330,216. Dyeing cellulose acetate. J. S. Wilson, J. Thomas, and Scottish Dyes, Ltd. November 27, 1928.

330,217. Anthraquinone derivatives, Production of. W. Smith, J. Thomas, and Scottish Dyes, Ltd. November 27, 1928.

330,218. Anthraquinone derivatives, Production of. W. Smith, J. Thomas and Scottish Dyes, Ltd. November 28, 1928.

330,221. Water-gas, Process of producing. D. Tyrer, H. G. Watts and Imperial Chemical Industries, Ltd. December 31, 1928.

330,222. Destructive hydrogenation of brown coal and other oxygen-containing low-grade fuels. H. W. Strong and Imperial Industries, Ltd. December 31, 1928.

330,223. Preparing liquid products from coal or coal-containing materials, and liquefying such materials, Process for. H. D Elkington (*Naamlooze Venootschap de Bataafsche Petroleum Maatschappij*). December 31, 1928.

330,226. Activating chemical reactions, Process for. L. Tocco. November 7, 1928.

330,228. Phosphoric acid esters, Manufacture and production of. J. Y. Johnson (*I.G. Farbenindustrie Akt.-Ges.*). January 31, 1929.

330,229. Lakes of triarylmethane dyestuffs. Imperial Chemical Industries, Ltd., F. W. Linch, E. H. Rodd, and H. K. Frew. January 31, 1929.

330,253. Colouring cellulose acetate. J. S. Wilson, J. Thomas, and Scottish Dyes, Ltd. November 27, 1928. Divided on 330,216.

330,255. Obtaining hydrogen peroxide by distillation, Process and apparatus for. Deutsche Gold- und Silber-Scheideanstalt, vorm. Roessler, and G. Baum. February 20, 1929.

330,257. Manganese dioxide, Manufacture of. Y. Kato and K. Yamamoto. February 26, 1929.

330,272. Artificial rubber, Manufacture of. A. Carpmael (*I.G. Farbenindustrie Akt.-Ges.*). December 29, 1929.

330,289. Cadmium plating. C. H. Humphries. October 1, 1928.

330,305. *o*-Hydroxycarboxylic acids of fluorene, Manufacture of. A. Carpmael (*I.G. Farbenindustrie Akt.-Ges.*). March 6, 1929.

330,308. Sulphur dyestuffs, Manufacture of. A. Carpmael (*I.G. Farbenindustrie Akt.-Ges.*). March 6, 1929.

330,332. Indoles, Manufacture of. Imperial Chemical Industries, Ltd. H. A. Piggott, and E. H. Rodd. March 26, 1929.

330,333. Monohydric phenols, Production of. Boots Pure Drug Co., Ltd., and J. Marshall. March 26, 1929.

330,349. Azo dyestuffs, insoluble in water, Manufacture of. W. W. Groves (*I.G. Farbenindustrie Akt.-Ges.*). April 12, 1929.

330,350. Catalytic manufacture and production of acetone from acetylene. J. Y. Johnson (*I.G. Farbenindustrie Akt.-Ges.*). April 13, 1929.

330,381. Purification of gases containing hydrogen sulphide. W. D'Leny, J. R. Park and Imperial Chemical Industries, Ltd. May 15, 1929.

330,453. Borax product and process of producing the same. American Potash and Chemical Corporation. April 9, 1929. Addition to 330,146.

Applications for Patents

[In the case of applications for patents under the International Convention, the priority date (that is, the original application date abroad which the applicant desires shall be accorded to the patent) is given in brackets, with the name of the country of origin. Specifications of such applications are open to inspection at the Patent Office on the anniversary of the date given in brackets, whether or not they have been accepted.]

Barthelemy, H. L. Manufacture of cellulose acetate. 18,395. June 16.

Boehringer und Soehne Ges., C. F. Altering solubility of cellulose acetates. 19,018. June 21. (Austria, June 21, 1929.)

Burman, A. S. Production of substantially pure chemical compounds or metals. 18,862. June 20. (Sweden, June 25, 1929.)

Carpmael, A. and I.G. Farbenindustrie Akt.-Ges. Manufacture of gold compounds. 18,670. June 18.

—— Manufacture of N-substituted 2-alkoxy-6-halogen 9-aminoacridines. 18,671. June 18.

Davies, A. Polymerisation of rubber distillates. 18,970. June 21.

Du Pont de Nemours and Co., E.I., and Imperial Chemical Industries, Ltd. Catalytic production of amines. 18,877. June 20.

Elkington, H. D. and Naamlooze Vennootschap de Bataafsche Petroleum Maatschappij. Manufacture of alkali, etc., metal salts of fatty acids. 18,798. June 19.

Groves, W. W. and I.G. Farbenindustrie Akt.-Ges. Manufacture of arylated safranines. 18,382. June 16.

—— Manufacture of azo-dyestuffs. 18,999, 19,000. June 21.

I.G. Farbenindustrie Akt.-Ges. and Johnson, J. Y. Production of enamelled articles. 18,630. June 18.

—— Production of anthraquinone derivatives. 18,631. June 18.

—— Dehalogenation of organic compounds. 18,769. June 19.

—— Production of carbon black. 18,987. June 21.

I.G. Farbenindustrie Akt.-Ges. Manufacture of hollow artificial silk. 18,381. June 16. (Germany, June 14, 1929.)

—— Process for improving the mechanical properties of magnesium alloys. 18,440. June 16. (Germany, June 29, 1929.)

—— Manufacture of rubber goods. 18,532. June 17. (Germany, June 17, 1929.)

—— Foils for cigarette tips. 18,628. June 18. (Germany, June 18, 1929.)

—— Manufacture of perfumes. 18,629. June 18. (Germany, June 18, 1929.)

—— Manufacture of higher fatty acid esters of polymeric carbohydrates. 18,775. June 19. (Germany, July 4, 1929.)

—— Device for ascertaining gradation of blackenings in photographic layers. 18,778. June 19. (Germany, December 20, 1929.)

—— Dehydration and electrolysis of hydrated magnesium chloride. 18,857. June 20. (Germany, June 20, 1929.)

—— Manufacture of basic products. 18,908. June 20.

Imperial Chemical Industries, Ltd. Burning pyrites. 18,362. June 16.

—— Production of sulphur from mineral sulphides. 18,365. June 16.

—— Production of sulphur from sulphur dioxide. 18,366. June 16.

—— Production of sulphur. 18,367. 18,368. June 16.

—— Manufacture of adhesive materials from rubber latex. 18,752. June 18.

—— Manufacture of ammonium chloride. 18,878. June 20. (United States, June 20, 1929.)

Institut für Physikalische Grundlagen der Medizin. Carrying out chemical reactions. 18,507. June 17. (Germany, June 26 1929.)

Lilly and Co., E. Anhydrous alkali-metal salts of 5, 5-di-aliphatic-substituted barbituric acids. 18,973. June 21. (United States, June 22, 1929.)

May and Baker, Ltd. Manufacture of metals and alloys. 18,742, 18,743. June 19.

Orthner, L. Manufacture of condensed products from formalde hyde. 18,781. June 19. (Germany, June 19, 1929.)

Pickard, J. A. Filtration systems. 18,865. June 20.

Ruth-Aldo Co., Inc. Manufacture of cellulose acetate. 18,395. June 16.

Soc. of Chemical Industry in Basle. Manufacture of dyestuff preparations. 18,510. June 17. (Switzerland, June 17, 1929.)

—— Dyeing cellulose esters, etc. 18,645. June 18. (Switzerland, June 18, 1929.)

—— Manufacture of metalliferous dyestuffs. 18,926. June 20. (Switzerland, June 20, 1929.)

—— Manufacture of condensation products containing sulphur. 18,927. June 20. (Switzerland, June 20, 1929.)

Tyrer, D. Burning pyrites. 18,362. June 16.

—— Production of sulphur from mineral sulphides. 18,365. June 16.

—— Production of sulphur from sulphur dioxide. 18,366. June 16.

—— Production of sulphur. 18,367. 18,368. June 16.

Weekly Prices of British Chemical Products

The prices and comments given below respecting British chemical products are based on direct information supplied by the British manufacturers concerned. Unless otherwise qualified, the figures quoted apply to fair quantities, net and naked at makers' works.

General Heavy Chemicals

ACID ACETIC, 40% TECH.—£19 per ton.
ACID, CHROMIC.—1s. 0¾d. per lb. d/d U.K.
ACID HYDROCHLORIC.—Spot, 3s. 9d. to 6s. per carboy d/d, according to purity, strength and locality.
ACID NITRIC, 80° Tw.—Spot £20 to £25 per ton, makers' works according to district and quality.
ACID SULPHURIC.—Average National prices f.o.r. makers' works, with slight variations up and down owing to local considerations; 140° Tw., Crude Acid, 60s. per ton. 168° Tw., Arsenical, £5 10s. per ton. 168° Tw., Non-arsenical, £6 15s. per ton.
AMMONIA (ANHYDROUS).—Spot, 11d. per lb., d/d in cylinders.
AMMONIUM BICHROMATE.—8½d. per lb. d/d U.K.
BISULPHITE OF LIME.—£7 10s. per ton, f.o.r. London, packages free.
BLEACHING POWDER, 35/37%.—Spot, £7 10s. per ton d/d station in casks, special terms for contracts.
BORAX, COMMERCIAL.—Crystals, £13 10s. per ton; granulated, £12 10s. per ton; powder, £14 per ton. (Packed in 1 cwt. bags carriage paid any station in Great Britain. Prices quoted are for one ton lots and upwards).
CALCIUM CHLORIDE (SOLID), 70/75%.—Spot, £4 15s. to £5 5s. per ton d/d in drums.
CHROMIUM OXIDE.—9½d. and 10d. per lb. according to quantity d/d U.K.
CHROMETAN.—Crystals, 3¾d. per lb. Liquor, £18 15s. per ton d/d U.K.
COPPER SULPHATE.—£25 to £25 10s. per ton.
METHYLATED SPIRIT 61 O.P.—Industrial, 1s. 7d. to 1s. 11d. per gall. pyridinised industrial, 1s. 9d. to 2s. 1d. per gall.; mineralised 2s. 8d. to 2s. 11d. per gall. 64 O.P., 1d. extra in all cases. Prices according to quantity.
NICKEL SULPHATE.—£38 per ton d/d.
NICKEL AMMONIA SULPHATE.—£38 per ton d/d.
POTASH CAUSTIC.—£30 to £33 per ton.
POTASSIUM BICHROMATE CRYSTALS AND GRANULAR.—4¾d. per lb. nett d/d U.K., discount according to quantity; ground ¼d. per lb. extra.
POTASSIUM CHLORATE.—3¾d. per lb., ex-wharf, London, in cwt. kegs.
POTASSIUM CHROMATE.—8½d. per lb. d/d U.K.
SALAMMONIAC.—Firsts lump, spot, £42 10s. per ton d/d station in barrels. Chloride of ammonia, £37 to £45 per ton, carr. paid.
SALT CAKE, UNGROUND.—Spot, £3 7s. 6d. per ton d/d station in bulk.
SODA ASH, 58° E.—Spot, £6 per ton, f.o.r. in bags, special terms for contracts.
SODA CAUSTIC, SOLID, 76/77°E.—Spot, £14 10s. per ton, d/d station.
SODA CRYSTALS.—Spot, £5 to £5 5s. per ton, d/d station or ex depot in 2 cwt. bags.
SODIUM ACETATE 97/98%.—£21 per ton.
SODIUM BICARBONATE, REFINED.—Spot, £10 10s. per ton d/d station in bags.
SODIUM BICHROMATE CRYSTALS.—3¾d. per lb. nett d/d U.K., discount according to quantity. Anhydrous ¾d. per lb. extra.
SODIUM BISULPHITE POWDER, 60/62%.—£17 10s. per ton delivered for home market, 1-cwt. drums included; £15 10s. f.o.b. London.
SODIUM CHLORATE.—2¾d. per lb.
SODIUM CHROMATE.—3½d. per lb. d/d U.K.
SODIUM NITRITE.—Spot, £19 per ton, d/d station in drums.
SODIUM PHOSPHATE.—£14 per ton, f.o.b. London, casks free.
SODIUM SILICATE, 140° Tw.—Spot, £8 5s. per ton, d/d station returnable drums.
SODIUM SULPHATE (GLAUBER SALTS).—Spot, £4 2s. 6d. per ton, d/d address in bags.
SODIUM SULPHIDE SOLID, 60/62%.—Spot, £10 5s. per ton d/d station in drums. Crystals—Spot, £7 10s. per ton d/d station in returnable casks.
SODIUM SULPHITE, PEA CRYSTALS.—Spot, £13 10s. per ton, d/d station in kegs. Commercial—Spot, £9 per ton, d/d station in bags.

Coal Tar Products

ACID CARBOLIC CRYSTALS.—7d. to 7½d. per lb. Crude 60's, 2s. 2d. to 2s. 5d. June, 2s. to 2s. 1d. July-Dec. per gall.
ACID CRESYLIC 99/100.—2s. 2d. to 2s. 6d. per gall. B.P., 5s. per gall. 97/99.—2s. 1d. to 2s. 2d. per gall. Refined, 2s. 7d. to 2s. 10d. per gall. Pale, 95%, 1s. 9d. to 1s. 10d. per gall. 98%, 2s. to 2s. 1d. Dark, 1s. 6d. to 1s. 8d.
ANTHRACENE.—A quality, 2d. to 2½d. per unit. 40%, £4 10s. per ton.
ANTHRACENE OIL, STRAINED, 1080/1090.—4½d. to 5½d. per gall. 1100, 5½d. to 6d. per gall.; 1110, 6d. to 6½d. per gall. Unstrained (Prices only nominal).
BENZOLE.—Prices at works: Crude, 10d. to 11d. per gall.; Standard Motor, 1s. 5d. to 1s. 6d. per gall.; 90%, 1s. 7d. to 1s. 8d. per gall.; Pure, 1s. 10d. to 1s. 11d. per gall.
TOLUOLE.—90%, 1s. 9d. to 1s. 11d. per gall. Pure, 1s. 11d. to 2s. 3d. per gall.
XYLOL.—1s. 5d. to 1s. 10d. per gall. Pure, 1s. 8d. to 2s. 1d. per gall
CREOSOTE.—Cresylic, 20/24%, 6¾d. to 7d. per gall.; Heavy, for Export, 6¼d. to 6⅜d. per gall. Home, 4d. per gall. d/d. Middle oil, 4¼d. to 5d. per gall. Standard specification, 3d. to 4d. per gall. Light gravity, 1¼d. to 1⅜d. per gall. ex works. Salty, 7½d. per gall.
NAPHTHA.—Crude, 8¼d. to 8¾d. per gall. Solvent, 90/160, 1s. 3d. to 1s. 3½d. per gall. Solvent, 95/160, 1s. 4d. to 1s. 6d. per gall. Solvent 90/190, 1s. to 1s. 2½d. per gall.
NAPHTHALENE, CRUDE.—Drained Creosote Salts, £4 10s. to £5 per ton. Whizzed, £4 10s. per ton. Hot pressed, £8 per ton.
NAPHTHALENE.—Crystals, £12 5s. per ton. Purified Crystals, £14 10s. per ton. Flaked, £14 to £15 per ton.
PITCH.—Medium soft, 46s. to 47s. 6d. per ton, f.o.b., according to district. Nominal.
PYRIDINE.—90/140, 3s. 9d. to 4s. per gall. 90/160, 3s. 6d. to 3s. 9d. per gall. 90/180, 1s. 9d. to 2s. 3d. per gall. Heavy prices only nominal.

Intermediates and Dyes

In the following list of Intermediates delivered prices include packages except where otherwise stated:

ACID AMIDONAPHTHOL DISULPHO (1-8-2-4).—10s. 9d. per lb.
ACID ANTHRANILIC.—6s. per lb. 100%.
ACID GAMMA.—Spot, 3s. 9d. per lb. 100% d/d buyer's works.
ACID H.—Spot, 2s. 3d. per lb. 100% d/d buyer's works.
ACID NAPHTHIONIC.—1s. 5d. per lb. 100% d/d buyer's works.
ACID NEVILLE AND WINTHER.—Spot, 2s. 7d. per lb. 100% d/d buyer's works.
ACID SULPHANILIC.—Spot, 8½d. per lb. 100% d/d buyer's works.
ANILINE OIL.—Spot, 8½d. per lb., drums extra, d/d buyer's works.
ANILINE SALTS.—Spot, 8½d. per lb. d/d buyer's works.
BENZALDEHYDE.—Spot, 1s. 8d. per lb., packages extra, d/d buyer's works.
BENZIDINE BASE.—Spot, 2s. 6d. per lb. 100% d/d buyer's works.
BENZOIC ACID.—Spot, 1s. 8½d. per lb. d/d buyer's works.
o-CRESOL 30/31° C.—£3 1s. 10d. per cwt., in 1 ton lots.
m-CRESOL 98/100%.—2s. 9d. per lb., in ton lots.
p-CRESOL 34·5° C.—1s. 9½d. per lb., in ton lots.
DICHLORANILINE.—1s. 10d. per lb. f.o.r. works.
DIMETHYLANILINE.—Spot, 1s. 9½d. per lb., drums extra d/d buyer's works.
DINITROBENZENE.—8d. per lb.
DINITROCHLORBENZENE.—£74 per ton d/d.
DINITROTOLUENE.—48/50° C., 7½d. per lb.; 66/68° C., 9d. per lb. f.o.r. works.
DIPHENYLAMINE.—Spot, 1s. 8d. per lb. d/d buyer's works.
a-NAPHTHOL.—Spot, 1s. 11d. per lb. d/d buyer's works.
B-NAPHTHOL.—Spot, £65 per ton in 1 ton lots, d/d buyer's works.
a-NAPHTHYLAMINE.—Spot, 1s. per lb. d/d buyer's works.
B-NAPHTHYLAMINE.—Spot, 2s. 9d. per lb. d/d buyer's works.
o-NITRANILINE.—5s. 11d. per lb.
m-NITRANILINE.—Spot, 2s. 6d. per lb. d/d buyer's works.
p-NITRANILINE.—Spot, 1s. 8d. per lb. d/d buyer's works.
NITROBENZENE.—Spot, 6½d. per lb, 5-cwt. lots, drums extra, d/d buyer's works.
NITRONAPHTHALENE.—9d. per lb.
R. SALT.—Spot, 2s. per lb. 100% d/d buyer's works.
SODIUM NAPHTHIONATE.—Spot, 1s. 6½d. per lb. 100% d/d buyer's works.
o-TOLUIDINE.—Spot, 8d. per lb., drums extra, d/d buyer's works.
p-TOLUIDINE.—Spot, 1s. 9d. per lb. d/d buyer's works.
m-XYLIDINE ACETATE.—3s. 1d. per lb. ex works.

Wood Distillation Products

ACETATE OF LIME.—Brown, £9 15s. to £10 5s. per ton. Grey, £16 10s. to £17 10s. per ton. Liquor, 9d. per gall.
ACETONE.—£78 per ton.
CHARCOAL.—£6 to £8 10s. per ton, according to grade and locality.
IRON LIQUOR.—1s. 3d. per gall. 32° Tw. 1s. per gall. 24° Tw.
WOOD CREOSOTE.—1s. 9d. per gall., unrefined.
WOOD NAPHTHA, MISCIBLE.—3s. 8d. to 3s. 11d per gall. Solvent, 4s. to 4s. 3d. per gall.
WOOD TAR.—£3 10s. to £4 10s. per ton
BROWN SUGAR OF LEAD.—£38 per ton.

Rubber Chemicals

ANTIMONY SULPHIDE.—Golden, 6½d. to 1s. 3d. per lb. according to quality; Crimson, 1s. 3d. to 1s. 5d. per lb., according to quality.
ARSENIC SULPHIDE, YELLOW.—1s. 8d. to 1s. 10d. per lb.
BARYTES.—£5 10s. to £7 per ton, according to quality.
CADMIUM SULPHIDE.—5s. to 6s. per lb.
CARBON BISULPHIDE.—£26 to £28 per ton, according to quantity; drums extra.
CARBON BLACK.—4 1/16d. to 4½d. per lb., ex wharf.
CARBON TETRACHLORIDE.—£40 to £50 per ton, according to quantity, drums extra.

CHROMIUM OXIDE, GREEN.—1s. 2d. per lb.
DIPHENYLGUANIDINE.—2s. 9d. per lb.
LITHOPONE, 30%.—£20 to £22 per ton.
SULPHUR.—£9 10s. to £13 per ton, according to quality.
SULPHUR CHLORIDE.—4d. to 7d. per lb., carboys extra.
SULPHUR PRECIP. B.P.—£55 to £60 per ton, according to quantity.
ZINC SULPHIDE.—8d. to 11d. per lb

Pharmaceutical and Photographic Chemicals

ACID, ACETIC, PURE, 80%.—£37 per ton, ex wharf London, barrels free.
ACID, ACETYL SALICYLIC.—2s. 9d. to 2s. 11d. per lb., according to quantity.
ACID, BENZOIC B.P.—2s. to 2s. 3d. per lb., for synthetic product, according to quantity. Solely ex Gum, 1s. 6d. per oz.; 50-oz. lots, 1s. 3d. per oz.
ACID, BORIC B.P.—Crystal, £31 per ton; powder, £32 per ton; For one ton lots and upwards. Packed in 1-cwt. bags carriage paid any station in Great Britain.
ACID, CAMPHORIC.—19s. to 21s. per lb.
ACID, CITRIC.—1s. 6d. to 1s. 6¾d. per lb., less 5%.
ACID, GALLIC.—2s. 11d. per lb. for pure crystal, in cwt. lots.
ACID, MOLYBDIC.—5s. 3d. per lb. in ¼ cwt. lots. Packages extra. Special prices for quantities and contracts.
ACID, PYROGALLIC, CRYSTALS.—7s. 3d. per lb. Resublimed, 8s. 3d.
ACID, SALICYLIC, B.P. PULV.—1s. 5d. to 1s. 8d. per lb. Technical.—1s. to 1s. 2d. per lb.
ACID, TANNIC B.P.—2s. 8d. to 2s. 10d. per lb.
ACID, TARTARIC.—1s. 1½d. per lb., less 5%.
ACETANILIDE.—1s. 5d. to 1s. 8d. per lb. for quantities.
AMIDOL.—7s. 6d. to 9s. per lb., d/d.
AMIDOPYRIN.—7s. 9d. to 8s. per lb.
AMMONIUM BENZOATE.—3s. 3d. to 3s. 9d. per lb., according to quantity. 18s. per lb. ex Gum.
AMMONIUM CARBONATE B.P.—£36 per ton. Powder, £39 per ton in 5 cwt. casks. Resublimated, 1s. per lb.
AMMONIUM MOLYBDATE.—4s. 9d. per lb. in ¼ cwt. lots. Packages extra. Special prices for quantities and contracts.
ATROPHINE SULPHATE.—9s. per oz.
BARBITONE.—5s. 9d. to 6s. per lb.
BENZONAPHTHOL.—3s. to 3s. 3d. per lb.
BISMUTH CARBONATE.—6s. 6d. per lb.
BISMUTH CITRATE.—6s. 9d. per lb.
BISMUTH SALICYLATE.—6s. 7d. per lb.
BISMUTH SUBNITRATE.—5s. 6d. per lb.
BISMUTH NITRATE.—Cryst. 4s. 4d. per lb.
BISMUTH OXIDE.—8s. 6d. per lb.
BISMUTH SUBCHLORIDE.—8s. per lb.
BISMUTH SUBGALLATE.—6s. 9d. per lb. Extra and reduced prices for smaller and larger quantities of all bismuth salts respectively.
BISMUTHI ET AMMON LIQUOR.—Cit. B.P. in W. Qts. 1s. 0½d. per lb.; 12 W. Qts. 11½d. per lb.; 36 W. Qts. 11d. per lb.
BORAX B.P.—Crystal, £21 10s. per ton; powder, £22 per ton; For one ton lots and upwards. Packed in 1-cwt. bags carriage paid any station in Great Britain.
BROMIDES.—Ammonium, 1s. 9d. per lb.; potassium, 1s. 5½d. per lb.; granular, 1s. 5d. per lb.; sodium, 1s. 8d. per lb. Prices for 1 cwt. lots.
CALCIUM LACTATE.—B.P., 1s. 1½d. to 1s. 3d. per lb., in 1-cwt. lots.
CAMPHOR.—Refined flowers, 3s. to 3s. 2d. per lb., according to quantity; also special contract prices.
CHLORAL HYDRATE.—3s. 1d. to 3s. 4d. per lb.
CHLOROFORM.—2s. 4½d. to 2s. 7½d. per lb., according to quantity.
CREOSOTE CARBONATE.—6s. per lb.
ETHERS.—S.G. ·730—1s. to 1s. 1d. per lb., according to quantity; other gravities at proportionate prices.
FORMALDEHYDE, 40%.—37s. per cwt., in barrels, ex wharf.
GUAIACOL CARBONATE.—4s. 6d. to 4s. 9d. per lb.
HEXAMINE.—2s. 3d. to 2s. 6d. per lb.
HOMATROPINE HYDROBROMIDE.—30s. per oz.
HYDRASTINE HYDROCHLORIDE.—English make offered at 120s. per oz.
HYDROGEN PEROXIDE (12 VOLS.).—1s. 4d. per gallon, f.o.r. makers' works, naked. B.P., 10 vols., 2s. to 2s. 3d. per gall.; 20 vols., 3s. per gall.
HYDROQUINONE.—3s. 9d. to 4s. per lb., in cwt. lots.
HYPOPHOSPHITES.—Calcium, 2s. 5d. per lb.; potassium, 2s. 8½d. per lb.; sodium, 2s. 7½d. per lb., in 1 cwt. lots, assorted.
IRON AMMONIUM CITRATE.—B.P., 2s. 5d. per lb. for 28 lb. lots. Green, 3s. 1d. per lb., list price. U.S.P., 2s. 4d. to 2s. 7d. per lb.
IRON PERCHLORIDE.—18s. to 20s. per cwt., according to quantity.
IRON QUININE CITRATE.—B.P., 8½d. to 8¾d. per oz., according to quantity.
MAGNESIUM CARBONATE.—Light commercial, £31 per ton net.
MAGNESIUM OXIDE.—Light commercial, £62 10s. per ton, less 2½%; Heavy commercial, £21 per ton, less 2½%; in quantity lower; Heavy Pure, 2s. to 2s. 3d. per lb.
MENTHOL.—A.B.R. recrystallised B.P., 17s. per lb. net; Synthetic, 9s. 6d. to 11s. per lb.; Synthetic detached crystals, 9s. 6d. to 11s. per lb., according to quantity; Liquid (95%), 9s. per lb.
MERCURIALS B.P.—Up to 1 cwt. lots, Red Oxide, crystals, 8s. 4d to 8s. 5d. per lb., levig., 7s. 10d. to 7s. 11d. per lb.; Corrosive Sublimate, Lump, 6s. 7d. to 6s. 8d. per lb., Powder, 6s. to 6s. 1d. per lb.; White Precipitate, Lump, 6s. 9d. to 6s. 10d. per lb., Powder, 6s. 10d. to 6s. 11d. per lb., Extra Fine, 6s. 11d. to 7s. per lb.; Calomel, 7s. 2d. to 7s. 3d. per lb.; Yellow Oxide, 7s. 8d. to 7s. 9d. per lb.; Persulph, B.P.C., 6s. 11d. to 7s. per lb.; Sulph. nig., 6s. 8d. to 6s. 9d. per lb. Special prices for larger quantities.
METHYL SALICYLATE.—1s. 3d. to 1s. 5d. per lb.
METHYL SULPHONAL.—18s. 6d. to 20s. per lb.
METOL.—9s. to 11s. 6d. per lb. British make.
PARAFORMALDEHYDE.—1s 9d. per lb. for 100% powder.
PARALDEHYDE.—1s. 4d. per lb.
PHENACETIN.—3s. 9d. to 4s. 1d. per lb.
PHENAZONE.—5s. 6d. per lb.
PHENOLPHTHALEIN.—5s. 11d. to 6s. 1½d. per lb.
POTASSIUM BITARTRATE 99/100% (Cream of Tartar).—93s. 6d. per cwt., less 2½ per cent.
POTASSIUM CITRATE.—B.P.C., 2s. 3d. per lb. in 28 lb. lots. Smaller quantities 1d. per lb. more.
POTASSIUM FERRICYANIDE.—1s. 7½d. per lb., in 125 lb. kegs
POTASSIUM IODIDE.—16s. 8d. to 17s. 2d. per lb., according to quantity.
POTASSIUM METABISULPHITE.—6d. per lb., 1-cwt. kegs included f.o.r. London.
POTASSIUM PERMANGANATE.—B.P. crystals, 5½d per lb., spot.
QUININE SULPHATE.—1s. 8d. to 1s. 9d. per oz., bulk in 100 oz. tins
RESORCIN.—2s. 10d. to 3s. per lb., spot.
SACCHARIN.—43s. 6d. per lb.
SODIUM BENZOATE B.P.—1s. 9d. per lb. for 1-cwt. lots.
SODIUM CITRATE, B.P.C., 1911, AND U.S.P. VIII.—1s. 11d. per lb., B.P.C. 1923, and U.S.P. IX—2s. 3d. per lb. Prices for 28 lb. lots. Smaller quantities 1d. per lb. more.
SODIUM FERROCYANIDE.—4d. per lb., carriage paid.
SODIUM HYPOSULPHITE, PHOTOGRAPHIC.—£15 per ton, d/d consignee's station in 1-cwt. kegs.
SODIUM NITROPRUSSIDE.—16s. per lb.
SODIUM POTASSIUM TARTRATE (ROCHELLE SALT).—95s. to 100s. per cwt. net. Crystals, 2s. 6d. per cwt. extra.
SODIUM SALICYLATE.—Powder, 1s. 10d. to 2s. 2d. per lb. Crystal, 1s. 11d. to 2s. 3d. per lb.
SODIUM SULPHIDE, PURE RECRYSTALLISED.—10d. to 1s. 2d. per lb.
SODIUM SULPHITE, ANHYDROUS.—£27 10s. to £29 10s. per ton, according to quantity. Delivered U.K.
SULPHONAL.—9s. 6d. to 10s. per lb.
TARTAR EMETIC, B.P.—Crystal or powder, 1s. 9d. to 2s. per lb.
THYMOL.—Puriss, 8s. 3½d. to 9s. 2d. per lb., according to quantity. Natural, 12s. per lb.

Perfumery Chemicals

ACETOPHENONE.—7s. per lb.
AUBEPINE (EX ANETHOL).—12s. per lb.
AMYL ACETATE.—2s. 6d. per lb.
AMYL BUTYRATE.—5s. per lb.
AMYL CINNAMIC ALDEHYDE.—11s. per lb.
AMYL SALICYLATE.—3s. per lb.
ANETHOL (M.P. 21/22° C.).—8s. per lb.
BENZALDEHYDE FREE FROM CHLORINE.—2s. 6d. per lb.
BENZYL ACETATE FROM CHLORINE-FREE BENZYL ALCOHOL.—2s. per lb.
BENZYL ALCOHOL FREE FROM CHLORINE.—2s. per lb.
BENZYL BENZOATE.—2s. 6d. per lb.
CINNAMIC ALDEHYDE NATURAL.—13s. 3d. per lb.
COUMARIN.—12s. per lb.
CITRONELLOL.—10s. per lb.
CITRAL.—8s. per lb.
ETHYL CINNAMATE.—6s. 6d. per lb.
ETHYL PHTHALATE.—2s. 9d. per lb.
EUGENOL.—9s. 6d. per lb.
GERANIOL (PALMAROSA).—18s. per lb.
GERANIOL.—7s. 6d. to 10s. per lb.
HELIOTROPINE.—6s. 6d. per lb.
ISO EUGENOL.—11s. 9d. per lb.
PHENYL ETHYL ACETATE.—11s. per lb.
PHENYL ETHYL ALCOHOL.—9s. per lb.
RHODINOL.—46s. per lb.
SAFROL.—2s. per lb.
TERPINEOL.—1s. 6d. per lb.
VANILLIN, EX CLOVE OIL.—13s. 6d. to 15s. per lb. Ex Guaiacol, 12s. 6d. to 13s. 9d. per lb.

Essential Oils

ALMOND OIL.—Foreign S.P.A., 10s. per lb.
ANISE OIL.—5s. per lb.
BERGAMOT OIL.—10s. 6d per lb.
BOURBON GERANIUM OIL.—20s. per lb.
CAMPHOR.—White, 2s. per lb.
CANANGA.—Java, 9s. 9d. per lb.
CASSIA OIL, 80/85%.—4s. 9d. per lb.
CINNAMON OIL LEAF.—6s. 9d. per oz.
CITRONELLA OIL.—Java, 2s. 7d. per lb., c.i.f. U.K. port.
LAVENDER.—Mont Blanc, 38 to 40%, 11s. per lb.
PALMA ROSA.—10s. 9d. per lb.

ROTARY
COMPRESSORS AND VACUUM PUMPS
of British Make

Made in Sizes 6 to 1,200 cub. ft. per minute capacity.

COMPRESSORS for pressures from 4 to 40 lbs. per sq. in.

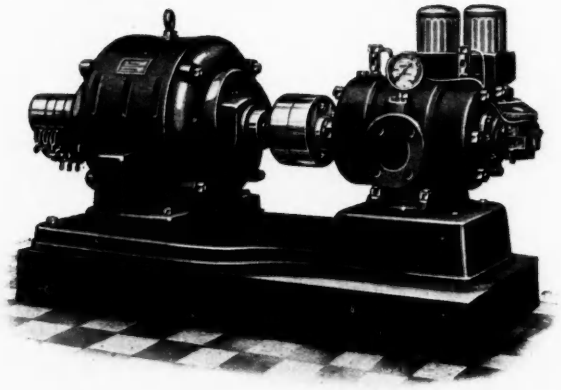
VACUUM PUMPS for vacuums within 23 inches of barometer.

ABSOLUTE SIMPLICITY

HIGHEST EFFICIENCY

AS a low pressure Compressor or Vacuum Pump, the "Broomwade" Rotary Machine is super-efficient and ideal in all respects. Strikingly simple in design, it is low in first cost and power consumption, of extremely compact dimensions, whilst 10 years' actual experience with many installations of this type has proved it to give lasting and reliable service.

BROOM & WADE LTD.
HIGH WYCOMBE



★

Send for Catalogue "R"

★

BROOMWADE
ROTARY COMPRESSORS & VACUUM PUMPS

London Chemical Market

The following notes on the London Chemical Market are specially supplied to* THE CHEMICAL AGE *by Messrs. R. W. Greeff & Co., Ltd., and Messrs. Chas. Page & Co., Ltd., and may be accepted as representing these firms' independent and impartial opinions.

London, June 25, 1930.

THE amount of business passing during the current week has been fairly satisfactory and continues to show a little improvement, with prices firm, with one or two exceptions. Export business continues steady.

General Chemicals

ACETONE.—£71 10s. to £80 per ton, according to quantity, with a regular demand.

ACETIC ACID.—Firm at £36 10s. for 80% Technical and £37 10s. per ton for 80% edible, and in good request.

ACID CITRIC.—Still very quiet at about 1s. 6½d. to 1s. 7d. per lb., less 5%.

ACID LACTIC.—Firm at £42 per ton for 50% by weight pale quality, and in good demand.

ACID OXALIC.—£30 7s. 6d. to £32 per ton, according to quantity.

SULPHATE OF AMMONIA.—Unchanged at about £8 to £8 15s. per ton for the 17/18% iron free quality.

ARSENIC.—£15 15s. per ton, free on rails at mines.

CREAM OF TARTAR.—In little better request at about 93s. to 94s. per cwt., ex wharf, London.

COPPER SULPHATE.—Unchanged at £21 10s. to £22 per ton, free on rails at mines.

FORMALDEHYDE.—Steady at about £33 per ton, with a steady demand.

LEAD ACETATE.—£40 5s. per ton for white and £39 5s. per ton for brown.

LEAD NITRATE.—£30 to £32, according to quantity.

LITHOPONE.—Firm at £19 15s. to £23 per ton, according to grade, and in regular demand.

CARBONATE OF POTASH.—£27 per ton for the 96/98% arsenic free quality, and in steady request.

PERMANGANATE OF POTASH.—Continues firm at 5½d per lb. for the B.P. quality, and the good demand continues.

SODIUM BICHROMATE.—3⅜d. per lb., and in steady request. Prices will be reduced on July 1 to 3⅜d. per lb.

SODA HYPOSULPHITE.—Photographic crystals in good demand at £14 15s. per ton, commercial at £8 10s. to £9 per ton.

SODIUM SULPHIDE.—Unchanged at British makers' prices

TARTAR EMETIC.—Continues slow at 11d. per lb.

ZINC SULPHATE.—Slow at about £12 10s. per ton.

Coal Tar Products

The market for coal tar products remains steady, but owing to bad coke sales, supplies are getting short, and there is a tendency to higher prices.

MOTOR BENZOL.—Firm at about 1s. 5⅞d. to 1s. 6⅛d. per gallon f.o.r.

SOLVENT NAPHTHA.—Unchanged at about 1s. 2½d. to 1s. 3d. per gallon, f.o.r.

HEAVY NAPHTHA.—Remains at about 1s. 1d. per gallon, f.o.r.

CREOSOTE OIL.—Unchanged at 3d. to 3½d. per gallon, f.o.r., in the north, and at 4d. to 4½d. per gallon in London.

CRESYLIC ACID.—Quoted at 2s. per gallon for the 98/100% quality, and at 1s. 10d. per gallon, ex works, for the dark quality 95/97%.

NAPHTHALENES.—The firelighter quality is quoted at £3 10s. to £3 15s. per ton, the 74/76 quality at £4 to £4 5s. per ton, and the 76/78 quality at about £5 per ton.

PITCH.—Obtainable at a nominal price of 40s. to 45s. per ton, f.o.b. East Coast port.

The following additional prices have been received :—

CARBOLIC ACID.—Unchanged at 7d. to 7½d. per lb.

CRESYLIC ACID.—Pale 98/100 quoted at 1s. 11d. to 2s. per gall. Refined grades, 2s. 6d. to 2s. 8d. Business quiet.

SALICYLIC ACID (B.P.).—1s. 5d. to 1s. 8d. per lb., according to quantity.

METHYL SALICYLATE.—Business steady at 1s. 3d. to 1s. 5d. per lb.

ASPIRIN.—Unchanged at 2s. 9d. to 2s. 11d. per lb.

Nitrogen Fertilisers

SULPHATE OF AMMONIA.—*Export.*—The export price remains about £7 7s. 6d. per ton f.o.b. U.K. port in single bags. The demand for immediate consumption is very small. Buyers for forward delivery are holding off until the new price scales for the year are arranged. *Home.*—The demand for immediate consumption is practically finished and merchants report only very small sales. It is hoped that the prices for 1930/31 will be announced shortly.

NITRATE OF SODA.—In view of the announcements already made from Chile, it is expected that the price scale for 1930/31 will show a considerable drop. At the moment there is very little interest in this product.

Latest Oil Prices

LONDON, June 25.—LINSEED OIL was easy for near deliveries. Spot, £42, nominal; July, £38 15s.; July-August, £38 5s.; September-December, £36 7s. 6d.; January-April, £34, naked. RAPE OIL was inactive. Crude extracted, £35 10s.; technical refined, £37, naked, ex-wharf. COTTON OIL was slow. Egyptian crude, £27 10s.; refined common edible, £32 10s.; deodorised, £33 10s., naked, ex-mill. TURPENTINE was dull and 9d. to 1s. per cwt. lower. American, spot, 30s.; July-December, 38s.

HULL.—LINSEED OIL.—Spot, £41 10s.; June, £41 5s.; July-August, £39 10s.; September-December, £37 5s. per ton, naked. COTTON OIL.—Egyptian crude, spot, £27 10s.; edible refined, spot, £30 10s.; technical, spot, £30 5s.; deodorised, spot, £30 10s. per ton, naked. PALM KERNEL OIL.—Crude, 5½ per cent., spot, £28 10s. per ton, naked. GROUNDNUT OIL.—Crushed-extracted, spot, £31; deodorised spot, £35 per ton. SOYA OIL.—Extracted and crushed, spot, £28 10s.; deodorised, spot, £32 per ton. RAPE OIL.—Crushed-extracted, spot, £34 10s.; refined, spot, £36 per ton. CASTOR OIL, TURPENTINE, and COD OIL unchanged.

South Wales By-Products

THERE is very little change to report in South Wales by-product activities, and the demand is mainly quiet and featureless. Pitch shows no improvement. Stocks are heavy and the demand slow, but prices are unchanged. Creosote remains inactive at from 2½d. to 4d. per gallon, but motor benzol continues to have a brisk call round 1s. 3d. to 1s. 5d. per gallon. Solvent naphtha has a steady, but moderate, call at from 1s. 2d. to 1s. 4d. per gallon, but heavy naphtha has scarcely any demand, with values unchanged. Road tar is quiet at from 10s. 6d. to 12s. 6d. per 40-gallon barrel at works. Refined tars are fairly good, with prices for coke oven and gasworks tar unchanged. There is no call for sulphate of ammonia. Patent fuel and coke exports are unsatisfactory. Patent fuel prices, for export, are :—22s., ex-ship Cardiff, and from 20s. to 21s., ex-ship Swansea and Newport. Coke prices are unchanged at all South Wales ports. Oil imports into Swansea over the four weeks ending June 17 amounted to 26,888,800 gallons.

Scottish Coal Tar Products

THE market continues dull, and very little interest is being shown in any product. Merchants and consumers alike are not buying in any great quantity, the former preferring to await developments and the latter being content to buy "from hand to mouth."

Cresylic Acid.—There is very little demand for any grade, and prices are weak. Pale, 99/100 per cent., 1s. 10d. to 1s. 11d. per gallon; pale, 97/99 per cent., 1s. 9d. to 1s. 10d. per gallon; dark, 97/99 per cent., 1s. 8d. to 1s. 9d. per gallon; high boiling, 1s. 9d. to 1s. 11d. per gallon; all free on rails.

Carbolic Sixties.—Production is small and value is nominal at about 2s. 3d. to 2s. 5d. per gallon.

Creosote Oil.—Only a few grades are in demand. Quotations remain steady as follows: Specification oil, 3d. to 3½d. per gallon; gas works ordinary, 3d. to 3½d. per gallon; washed oil, 3¼d. to 3¾d. per gallon; all free on rails, makers' works.

Coal Tar Pitch is in poor call for prompt or forward. Nominal export value is unchanged at about 47s. 6d. per ton, f.a.s. Glasgow, while home value is weak at 50s. per ton, f.o.r. works.

Blast Furnace Pitch is quiet and fixed prices are unchanged at 30s. per ton f.o.r. works for home, and 35s. per ton, f.a.s. Glasgow for export.

Refined Coal Tar.—This is the only item which is keeping tar distillers busy. The output is well maintained and value is steady at 3½d. to 4d. per gallon f.o.r. makers' works in buyers' packages.

Blast Furnace Tar remains at 2¾d. per gallon.

Crude Naphtha.—There is very little movement and value is about 4d. to 4½d. per gallon ex makers' works.

Water White Products are in fair call with prices firm; 90/160 solvent is 1s. 3d. to 1s. 4d. per gallon; 90/190 is 1s. 1d. to 1s. 2d. per gallon; motor benzole is 1s. 6¼d. to 1s. 7d. per gallon; all free on rails in bulk.

HOWARDS' SOLVENTS

FOR THE

VARNISH, LACQUER, PAINT, TEXTILE, DRY-CLEANING & LAUNDRY, &c., TRADES

For Cellulose Lacquers

SEXTONE "B"

(Methylcyclohexanone)

Has a high dilution ratio and is a powerful Solvent of Resins, Nitrocellulose, &c.

Ethyl Lactate & DIACETONE Alcohol

Excellent Solvents for Cellulose Acetate.

PLASTICISER.

BARKITE

(Methylcyclohexanol Oxalate)

The Ideal Plasticiser for White Enamels. Considerably reduces the inflammability of Lacquers.

Samples and Prices from the Manufacturers:

HOWARDS & SONS Ltd. (Est. 1797), ILFORD, LONDON

E

Scottish Chemical Market

The following notes on the Scottish Chemical Market are specially supplied to THE CHEMICAL AGE *by Messrs. Charle Tennant and Co., Ltd., Glasgow, and may be accepted as representing this firm's independent and impartial opinions.*

Glasgow, June 25, 1930.

PRICES for the Scottish heavy chemical market remain steady generally, minor fluctuations of little account taking place.

Industrial Chemicals

ACETONE, B.G.S.—£71 10s. to £80 per ton, ex wharf, according to quantity. Inquiry remains satisfactory.

ACID, ACETIC.—Prices ruling are as follows: Glacial 98/100%, £53 to £64 per ton; pure, £37 10s. per ton; technical 80%, £37 10s. per ton, ex wharf.

ACID BORIC.—Granulated £22 per ton; crystals £23 per ton; powder £24 per ton, packed in 1 cwt. bags, delivered free Great Britain in one ton lots and upwards.

ACID HYDROCHLORIC.—Usual steady demand. Arsenical quality, 4s. per carboy. Dearsenicated quality, 5s. 6d. per carboy, ex works, full wagon loads.

ACID NITRIC, 80° QUALITY.—£24 10s. per ton, ex station, full truck loads.

ACID OXALIC, 98/100%.—On offer at the same price, viz.: 3¼d. per lb., ex store. Offered from the Continent at 3⅛d. per lb., ex wharf.

ACID SULPHURIC.—£2 15s. per ton, ex works for 144° quality; £5 15s. per ton for 168°. Dearsenicated quality, 20s. per ton extra.

ACID TARTARIC B.P. CRYSTALS.—Quoted 1s. 4d. per lb., less 5%, ex wharf. On offer for prompt delivery from the Continent at 1s. 4½d. per lb., less 5%, ex wharf.

ALUMINA SULPHATE.—Quoted at round about £8 15s. per ton, ex store.

ALUM, LUMP POTASH.—Now quoted £8 7s. 6d. per ton, c.i.f., U.K. ports. Crystal Meal about 2s. 6d. per ton less.

AMMONIA ANHYDROUS.—Quoted 10½d. per lb. Containers extra and returnable.

AMMONIA CARBONATE.—Lump quality quoted £36 per ton. Powdered, £38 per ton, packed in 5 cwt. casks, delivered U.K. stations or f.o.b. U.K. ports.

AMMONIA LIQUID, 880°.—Unchanged at about 2½d. to 3d. per lb., delivered according to quantity.

AMMONIA MURIATE.—Grey galvanisers' crystals of British manufacture quoted £21 to £22 per ton, ex station. Fine white crystals offered from the Continent at about £17 5s. per ton, c.i.f., U.K. ports.

ANTIMONY OXIDE.—Rather easier and spot material now obtainable at round about £30 per ton, ex wharf. On offer for prompt shipment from China at about £27 per ton, c.i.f., U.K. ports.

ARSENIC, WHITE POWDERED.—Quoted £18 per ton, ex wharf, prompt shipment from mines. Spot material still on offer at £19 15s. per ton, ex store.

BARIUM CHLORIDE.—In good demand and price about £11 per ton, c.i.f., U.K. ports. For Continental material our price would be £10 per ton, f.o.b., Antwerp or Rotterdam.

BLEACHING POWDER.—British manufacturers' contract price to consumers unchanged at £6 12s. 6d. per ton, delivered in minimum 4-ton lots. Continental now offered at about the same figure.

CALCIUM CHLORIDE.—Remains unchanged. British manufacturers' price £4 15s. per ton to £5 5s. per ton, according to quantity and point of delivery. Continental material on offer at £3 12s. 6d. per ton, c.i.f. U.K. ports.

COPPERAS, GREEN.—Unchanged at about £3 10s. per ton, f.o.r. works or £4 12s. 6d. per ton, f.o.b. U.K. ports.

FORMALDEHYDE 40%.—Now quoted £33 10s. per ton, ex store. Continental material now on offer at about £34 per ton, ex wharf.

GLAUBER SALTS.—English material, quoted £4 10s. per ton, ex station. Continental on offer at about £3 per ton, ex wharf.

LEAD, RED.—Price now £34 10s. per ton, delivered buyers' works.

LEAD, WHITE.—Quoted £53 10s. per ton, c.i.f. U.K. ports.

LEAD, ACETATE.—White crystals quoted round about £39 to £40 per ton, ex wharf. Brown on offer at about £2 per ton less.

MAGNESITE, GROUND CALCINED.—Quoted £8 10s. per ton, ex store. In moderate demand.

METHYLATED SPIRIT.—Industrial quality 64 O.P. quoted 1s. 8d. per gallon, less 2½% delivered.

POTASSIUM BICHROMATE.—Quoted 4½d. per lb. delivered U.K. or c.i.f. Irish ports, with an allowance for contracts.

POTASSIUM CARBONATE.—Spot material on offer at £26 10s. per ton, ex store. Offered from the Continent at £25 5s. per ton, c.i.f. U.K. ports.

POTASSIUM CHLORATE.—99¾/100% Powder. Quoted £25 10s. per ton, ex wharf. Crystals 30s. per ton extra.

POTASSIUM NITRATE.—Refined granulated quality quoted £19 2s. 6d. per ton c.i.f. U.K. ports. Spot material on offer at about £20 10s. per ton, ex store.

POTASSIUM PERMANGANATE B.P. CRYSTALS.—Quoted 5¼d. per lb. ex wharf.

POTASSIUM PRUSSIATE (YELLOW).—Spot material quoted at 7d. per lb., ex store. Offered for prompt delivery from the continent at about 6¾d. per lb., ex wharf.

SODIUM BICARBONATE.—Refined recrystallised £10 10s. per ton, ex quay or station, M.W. quality 30s. per ton less.

SODIUM BICHROMATE.—Quoted 3⅞d. per lb., delivered buyer's premises with concession for contracts.

SODIUM CARBONATE (SODA CRYSTALS).—£5 to £5 5s. per ton, ex quay or station. Powdered or pea quality, 27s. 6d. per ton extra. Light soda ash, £7 13s. per ton, ex quay minimum four-ton lots with various reductions for contracts.

SODIUM CAUSTIC.—Powdered, 98/99%, £17 10s. per ton in drums; £18 15s. per ton in casks. Solid, 76/77%, £14 10s. per ton in drums; £14 12s. 6d. per ton for 70/72% in drums, all carriage paid buyers' stations, minimum four-ton lots. For contracts 10s. per ton less.

SODIUM HYPOSULPHITE.—Large crystals of English manufacture quoted £8 17s. 6d. per ton, ex station, minimum four-ton lots. Pea crystals on offer at £14 15s. per ton, ex station, minimum four-ton lots. Prices for this year unchanged.

SODIUM NITRATE.—Chilean producers are now offering at £10 2s. per ton, carriage paid buyers' sidings, minimum six-ton lots, but demand in the meantime is small.

SODIUM PRUSSIATE.—Quoted 5¼d. per lb., ex store. On offer at 5d. per lb., ex wharf to come forward.

SODIUM SULPHATE (SALTCAKE).—Prices 55s. per ton, ex works, 57s. 6d. per ton delivered for unground quality. Ground quality, 2s. 6d. per ton extra.

SODIUM SULPHIDE.—Prices for home consumption: solid, 61/62%, £9 15s.; broken, 60/62%, £10 15s. per ton; crystals, 30/32%, £7 17s. 6d. per ton, all delivered buyers' works on contract minimum four-ton lots. Special prices for some consumers. Spot material 5s. per ton extra.

SULPHUR.—Flowers, £12 per ton; roll, £10 10s. per ton; rock, £9 5s. per ton; ground American, £9 5s. per ton, ex store.

ZINC.—Chloride 98%.—British material offered at round about £20 per ton f.o.b. U.K. ports.

ZINC SULPHATE.—Quoted £10 per ton, ex wharf.

NOTE.—The above prices are for bulk business and are not to be taken as applicable to small parcels.

Leeds University Library

Foundation Stone Laid by Lord Brotherton

LORD BROTHERTON of Wakefield, whose gift of £100,000 has made the project possible, on Tuesday laid the foundation stone of the new library of the University of Leeds, in the presence of a large gathering. The donor has announced that his own very valuable collection of books shall be housed in the new library, held by the University in perpetual trust for the nation and endowed by him. The Duke of Devonshire, who is Chancellor of the University, read a message of good wishes from the King and went on to say that they were happy to witness the first stage in the construction of what they had every reason to believe would be one of the finest library buildings possessed by any University in this country.

Dr. Offor, the University librarian, said the number of books they could house would be something like a million, and no university in this country, outside Oxford and Cambridge, had yet provided such accommodation for its central library. The most striking innovation was that they would be able to place a quarter of a million volumes on shelves that were open to the access of all readers.

"Industry must depend more and more on science," declared Lord Brotherton, "and the advantages of University education must be given to as many as can profit by them." He liked to think, he added that all students would have the opportunity to wander freely through the rooms of a great library. But a great library in a great university was a trust for the nation at large, and should not be looked on as exclusively available to its own students. He hoped that in course of time this library might be rich enough in books of all kinds to attract scholars from all parts of Great Britain and from countries abroad.

BRITISH CARBO UNION

HIGHEST EFFICIENCY IN

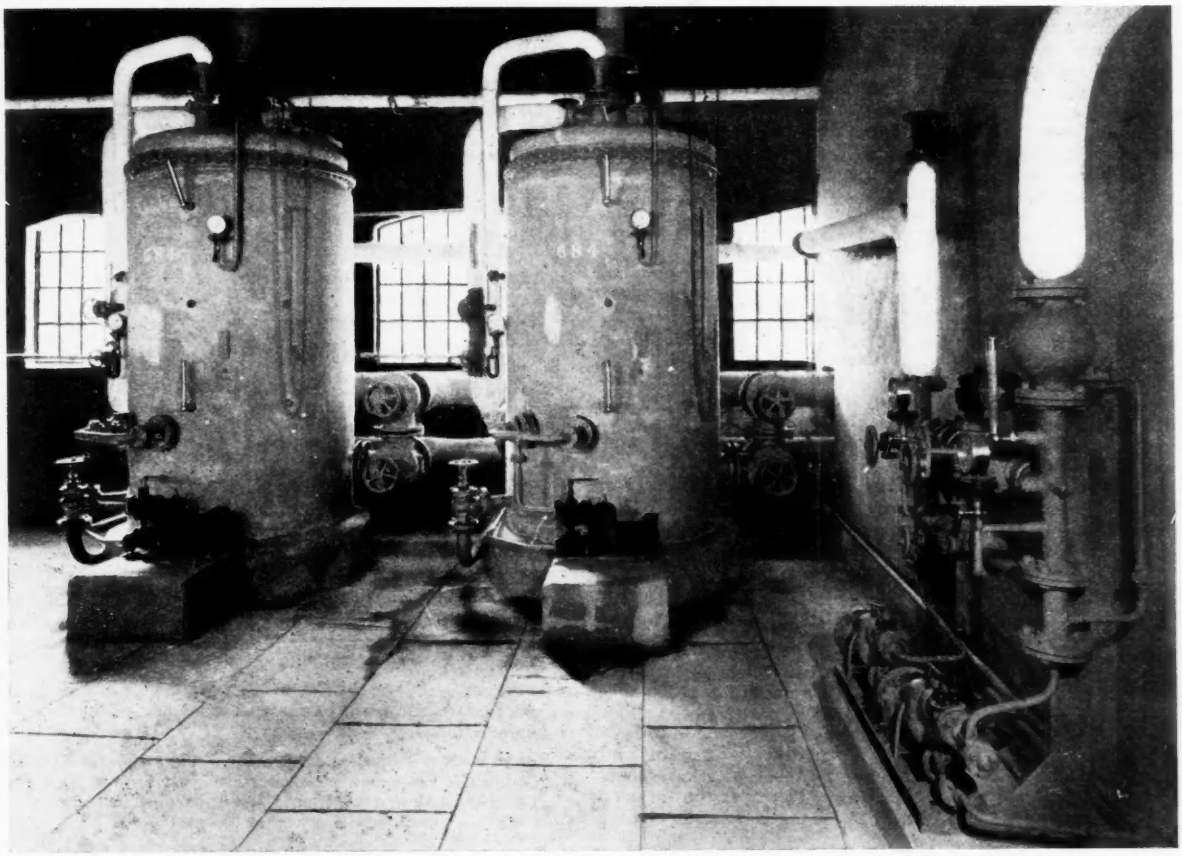
SOLVENT RECOVERY

AND LOW OPERATING COSTS

ATTAINABLE ONLY BY

ACTIVE CARBON

SUITABLE FOR ALL INDUSTRIES USING SOLVENTS



One of our Solvent Recovery Plants in course of erection at Messrs. Wm. Warne & Co., Ltd., Barking.

BRITISH CARBO UNION, Ltd.,

BUSH HOUSE, ALDWYCH

LONDON, W.C.2

Telegrams: "Bricarbun, Estrand, London."

Codes: Bentley's: Rudolf Mosse

Telephone: Temple Bar 1473

Manchester Chemical Market

(From Our Own Correspondent.)

Manchester, June 26, 1930.

On the whole, the movement of chemicals on this market since last report has been pretty well up to the level which prevailed before Whitsuntide, and in view of the present condition of the cotton and allied industries this seems to be about as much as can be expected in this part of the country. With a few exceptions, deliveries against contracts are only of moderate extent and at the moment there is not a big volume of inquiry coming on to the market. In several lines prices have eased a little during the past week.

Heavy Chemicals

There is a moderate movement in the case of prussiate of soda, offers of which are well held at from 4¾d. to 5¼d. per lb., according to quantity. Caustic soda meets with a quietly steady demand and contract prices of this material keep up from £12 15s. to £14 per ton, according to quality. Chlorate of soda this week has been rather a slow section of the market, and quotations are easy in tendency at round £24 15s. per ton. Bichromate of soda is attracting a fair amount of attention, with current values on the basis of 3⅜d. per lb., less 1 to 3½ per cent. A quiet trade is passing in the case of phosphate of soda, the dibasic quality being fully maintained at from £11 to £11 10s. per ton. Hyposulphite of soda is in moderate request, with the photographic quality quoted at about £15 5s. per ton, and the commercial at £9. Only a relatively slow business has been reported this week in respect of saltcake, offers of which, however, are reasonably steady at about £3 per ton. Bicarbonate of soda and alkali are moving in moderate quantities and quotations in both cases are well held at round £10 10s. and £6 per ton, respectively. The demand for sulphide of sodium is on the quiet side at the moment, with the commercial quality on offer at about £8 per ton and the 60-65 per cent. concentrated solid material at £10.

Some easiness is apparent in respect both of caustic potash and carbonate, and buying interest is on a modest scale; caustic is quoted to-day at from £29 to £30 per ton, and carbonate at round £25. Permanganate of potash is steady, although only in quiet demand at 5½d. per lb. for the B.P. grade and round 5¼d. for the commercial material. Yellow prussiate of potash is attracting a moderate amount of buying interest, and prices are maintained at from 6¾d. to 7¼d. per lb., according to quantity. Bichromate of potash is on offer on the basis of 4⅛d. per lb., a quietly steady trade being put through. With regard to chlorate of potash, current prices are at round £26 10s. per ton, but relatively little weight of business in this material has been reported during the past week.

Sulphate of copper is only in quiet demand and in view of the metal uncertainties prices are now no better than about £24 per ton, f.o.b. Arsenic seems to be fractionally steadier than before, although there has been no apparent improvement in trade; white powdered, Cornish makes, are quoted at about £16 per ton, at the mines. Slow inquiry is reported in respect of the lead products, with nitrate at about £29 per ton and brown and white acetate at £36 and £37. Interest in acetate of lime is of limited extent but at round £15 per ton for grey and £7 5s. for brown there has not been a great deal of change on balance.

Acids and Tar Products

Signs of weakness are still to be observed in respect of both tartaric and citric acids and the demand this week has been quiet; current offers are at round 1s. 1¼d. and 1s. 6½d. per lb., respectively. Acetic acid keeps firm and is in fair request at £66 per ton for the glacial quality and £36 for the commercial 80 per cent. Oxalic acid is unchanged on the week at £1 12s. per cwt., ex store, but only a quiet trade has been put through.

Home and export sales of creosote oil have been on the quiet side, with quotations at from 3d. to 4d. per gallon, naked, according to grade. Pitch continues to be quoted at about 47s. 6d. per ton, f.o.b., but actual business is slow. A quiet trade is going through in the carbolic section, with crystals at about 7d. per lb., f.o.b., and crude 60's material at 2s. 4½d. per gallon, naked. Solvent naphtha is on the easy side at round 1s. 2½d. per gallon, naked.

Company News

Andrade Nitrate.—After providing for London office expenses, debenture interest, stoppage expenses, directors' fees, etc., there is a loss for the past year of £2,986.

American Cyanamid Co.—Quarterly dividends of 40 cents per share on Class "A" and Class "B" common stocks are announced, payable on July 2.

British Drug Houses, Ltd.—The directors recommend the usual quarterly 1¾ per cent. on the preference shares, payable on June 30.

Tarmac.—The directors recommend a dividend of 5½ per cent., tax free, on the preference shares for the half-year to June 30, payable on July 1.

Continuous Coal Carbonisation.—The accounts sho that the expenditure for 1929 amounted to £17,281, which increases the debit to development and general expenditure account to £51,137.

Major and Co.—A profit of £22,285 is announced for the year ended March 31, 1930, which, with the amount brought forward, makes £25,227. The directors recommend payment of a dividend of 10 per cent. on the ordinary shares for the year, placing £2,000 to reserve, leaving, after payment of directors' fees, £2,927 to be carried forward. The annual meeting will be held at Hull on June 27.

Angela Nitrate Co.—The profit and loss account shows a gross profit for the year ended December 31, 1929, of £9,225, and after deducting London expenses, income tax (Chile), legal charges, interest, etc., there is a net profit of £3,847, to which is added balance brought forward of £3,019, making £6,866. Interim dividend of 10 per cent. (2s. per share), less tax, paid November 25, 1929, absorbed £5,600, leaving balance of £1,266 to be carried forward. The report states that the manufacture of nitrate has proceeded steadily throughout the year.

Chemical Trade Inquiries

The following inquiries, abstracted from the "Board of Trade Journal," have been received at the Department of Overseas Trade (Development and Intelligence), 35, Old Queen Street, London, S.W.1. British firms may obtain the names and addresses of the inquirers by applying to the Department (quoting the reference number and country), except where otherwise stated.

Canada.—The city of Hamilton, Ontario, is proposing to instal a new filtration plant for which tenders will be required. Ref. No. A.X. 9,733.

Colombia.—H.M. Vice-Consul at Bogota reports that a local agent desires to receive from British manufacturers particulars of creosoting plants of moderate price, together with information as to the best means of applying creosote. Ref. No. A.X. 9,688.

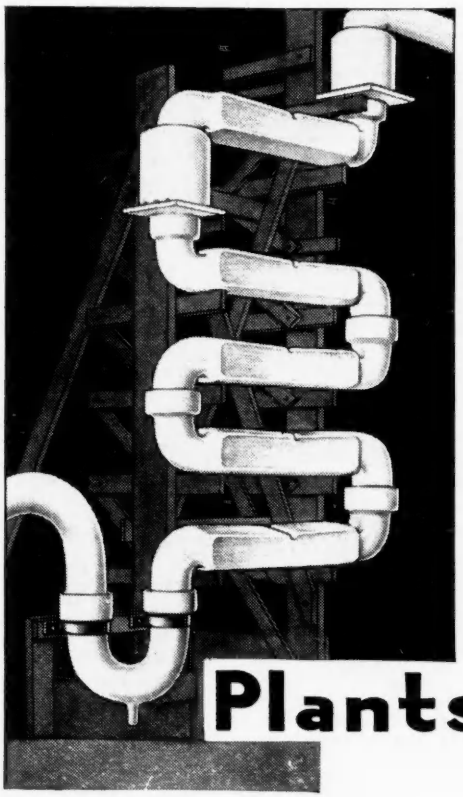
Switzerland.—An agent in Geneva desires to represent British manufacturers of paints and varnishes, preferably on a consignment basis. Ref. No. 534.

Egypt.—The Egyptian Ministry of Agriculture is calling for tenders, to be presented in Cairo by July 20, for the supply of: 10 tons calcium arsenate, 300 tons sulphuric acid, 100 tons sodium cyanide. (Ref. No. 6,603.)

Tariff Changes

Turkey.—The following chemical products are affected by the proposed tariff reductions, which will apply to products of the United Kingdom (most favoured nation treatment) as the result of the signing of the Turkish treaty with Germany; lithopone to be £T8·1 per 100 kilogs (instead of £T9 at present); chloride of magnesium, 4·05 (4·50); chrome oxide preparations for tanning, 30·375 (33·75); medicinal and chemical specialities 20 per cent. *ad val.* (25 per cent.). Nitrate of potash is now to be dutiable at £T1¼ per 100 kilogs, and Iehytol £T127½ per 100 kilogs.

Martinique.—The proposed alteration of the duties on mineral oils and residues has not been approved by the French Government and the 1922 rates therefore remain.



Difficulties Disappear When . . Vitreosil Plants are installed!

THE illustration shows a column of VITREOSIL Absorption Vessels for Hydrochloric Acid Manufacture. This system is economical of ground space, has no submerged joints, and has a high absorption efficiency.

VITREOSIL does not sweat, crack or disintegrate, and being quite unaffected by the acid, gives a water-white product. The plant can be stopped and quickly re-started without damage.

Why not know all about the VITREOSIL System? If your works are in the United Kingdom we will gladly place an advisory expert at your service. May we send you descriptive literature?

Write:
The Thermal Syndicate, Ltd.,
VITREOSIL Works,
Wallsend-on-Tyne.

London Depot:
Thermal House, Old Pye St.,
S.W.1

VITREOSIL
PURE FUSED QUARTZ OR SILICA

The plant that speeds up production and effects economies.

SYSTEM OF HYDROCHLORIC ACID ABSORPTION.

Chemical Matters in Parliament

Fertilisers Act and Civil Remedies

THE Fertilisers and Feeding Stuffs Act, 1926, formed the subject of a question in the House of Commons on June 23 by Lt.-Col. Acland-Troyte, who asked the Minister of Agriculture whether he had received complaints that the limitation of the purchaser's powers, in respect of samples taken after the goods had left the sellers' premises, to civil remedies had failed to give adequate protection to the farmers; and whether he would consider amending the Act so as to restore to local authorities the power to take criminal proceedings.

Dr. Addison replied that he had received a resolution on the subject passed by one County Council and supported by three others, but he could not agree that the Act had proved ineffective. An amendment of the nature indicated would be contrary to the unanimous recommendation of the Departmental Committee on whose report the Act was based.

River Tamar Tin Alluvials

QUESTIONED by Mr. Hore-Belisha in the House of Commons on June 24 as to whether the inquiries into the suggested establishment of the new tin alluvials industry on the River Tamar had been completed, the President of the Board of Trade (Mr. W. Graham) replied that inquiries had been made, but it did not appear that there was any action which the Government might usefully take.

Mr. Hore-Belisha: Is the right hon. gentleman aware that over £1,000,000 is offered by private sources for the development of this new industry, which cannot proceed because of certain fishing rights which are held by individuals? What he is asked to do is to exercise his influence in the matter in order that some of the unemployed may be absorbed and the country may be enriched.

Mr. Graham: Part of the difficulty is the doubt as to whether this could be in any circumstances an economic enterprise, and, if there is that doubt, of course it would be very difficult to raise any question as to fishing rights.

Mr. Hore-Belisha further stated that the whole risk was to be taken by those who were putting up the money, and the State risked nothing at all.

Bleachers' Association, Ltd.

Review of a Difficult Year

SIR ALAN SYKES, presiding at the annual meeting of the Bleachers' Association, in Manchester, on Friday, June 20, said the profit for the year showed a decrease of £133,716, and this reflected the obstacles with which the trade of the association had been met during the past year.

In the year 1929–30 the total exports of bleached goods recorded in the Board of Trade were 1,244 million square yards, compared with 1,376 million square yards in 1928–29, a decrease of 132 millions. More than one-half of the decrease was accounted for by reduced exports to India, which were less by 79 million yards (13·5 per cent.). The decrease in exports to China amounted to 25 million yards (24·5 per cent.), and to the Dutch East Indies to 17 million yards (27·4 per cent.). The last two markets account for more than 30 per cent. of the decrease, and with India account for more than 90 per cent. of the total reduction. The improved demand which was manifest in the first quarter of 1929 continued, although slightly below the level of 1928, until the summer, but in the third quarter of the year a severe check was administered to trade by the unfortunate stoppage in the spinning and weaving industry.

Sir Alan said the present year had opened under far less favourable conditions than that which had just closed, and, unless there was a marked improvement, it would seem to be inevitable that the profits of their business must show further contraction. Signs were not lacking, however, that the present depression had almost run its course, but the general consensus of opinion appeared to be that recovery would be slow. For the improvement they desired they must look, not only to the dispersal of the clouds which overhang India and the removal of the hindrances to trade with China, but to a general enhancement of world prosperity. In this a greater stability of the exchange values of commodities was by no means the least important factor. Competition from Japan should be somewhat less difficult to meet since the return of that country to the gold standard.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

Mortgages and Charges

[*NOTE.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.*]

ENDOCRINES, LTD., London, W., manufacturers of medicinal preparations. (M., 28/6/30.) Registered June 14, £200 debentures, part of £5,000; general charge (except property at Watford on which they are a second charge). *Nil. March 11, 1929.

HAM FRITH CHEMICAL CO., LTD., London, E. (M., 28/6/30.) Registered June 14, series of £1,200 debentures, present issues £600 and £600; general charge. *Nil. September 30, 1929.

London Gazette, &c.

Bankruptcy Information

STOTT, Milton, 6, Hyde Park, Halifax, Yorks, formerly trading in co-partnership with Herbert Sykes under the name of MILTON STOTT AND CO., at Oxford Works, Siddal, near Halifax, manufacturing chemists. (R.O., 28/6/30.) Receiving order, June 14. Debtor's petition.

New Companies Registered

BAGNALL STEWART, LTD., 1, Newton Street, Holborn, London, W.C.2.—Registered June 19. Nominal capital, £100 in £1 shares. Manufacturers of and dealers in all machinery, implements, lubricants, cements, solutions, enamels and all things capable of being used in connection with internal combustion engines or in any vehicles moved by mechanical, petrol or electric power; to engage in chemical research, discovery and invention, and to prepare, manufacture and sell or deal in synthetic and other chemical substances, etc. Directors: E. B. Bull, W. S. Whitelaw, L. G. Ridout, T. M. Jefferson.

DECRUSTA (PARENT) CO., LTD., 118, Queen Victoria Street, London, E.C.4.—Registered June 19. Nominal capital, £100 in 1s. shares. Objects: To acquire patents and a secret process for the manufacture of a preparation designed or adapted for clearing lime scale and other impurities from boilers and pipes invented by E. Hertig, and to carry on the business of chemical manufacturers and engineers, etc. Directors: G. Cumming, E. Hertig.

THE MORGAN CRUCIBLE CO., LTD., Battersea Works, Church Road, Battersea, London. Registered as a public company on June 18, with a nominal capital of £3,258,000 in £1 shares. The objects are to acquire as a going concern the business of manufacturers of and dealers in crucibles, pottery and assay ware, refractory, chemical and abrasive ware, foundry requisites, carbon, graphite and metallic blocks, brushes and resisters and similar accessories for the electrical trade, plumbago, graphite, clay and other refractory materials, and generally the undertaking and all or any of the assets, rights, powers, liabilities and duties of the Morgan Crucible Co., Ltd. (incorporated in 1890), pursuant to a scheme of arrangement and reconstruction under Sections 153 and 154 of the Companies Act, 1929, sanctioned by an Order of Court (Chancery Division) on June 6, 1930, or otherwise as may be considered expedient. Directors: Stanley Beeton, Alexander R. Bosman, William F. Coaker, Geo. W. Edward, Lewis J. E. Hooper, Capt. Peter Lindsay, Lt.-Col. Sir K. P. Vaughan-Morgan, Capt. Geoffrey K. Peto, Chas. W. Spiers.

The Dyestuffs Monthly Supplement

A Section devoted to the Manufacture and Use of Dyes Published in THE CHEMICAL AGE the Second Week of each Month

Your enquiries for

ACIDS and CHEMICALS

will be esteemed

ACIDS—
- Accumulator Acid
- Sulphuric Acid
- Hydrochloric Acid
- Dipping Acid
- Nitric Acid

BICHROMATES—
- Sodium and Potassium

SALTCAKE

GLAUBER SALTS

EPSOM SALTS

COPPERAS

ZINC—
- Oxides
- Sulphate

CAUSTIC SODA—
- Solid
- Powdered
- Liquid
- Broken

COPPER SUBOXIDE

SODIUM HYPOCHLORITE

BLEACHING LIQUOR

TEXTILE SOAPS

HARRISON BLAIR & CO., LTD.

Chemical Manufacturers

Farnworth, Bolton

Telephone: *Farnworth* 410 (2 *lines*)

"Everything for Safety Everywhere."

SMOKE HELMETS.

GAS MASKS.

BREATHING APPARATUS OF ALL PATTERNS.

OXYGEN RESUSCITATING APPARATUS.

FIRE EXTINGUISHERS.

FIRST-AID OUTFITS.

SAFETY AND PROTECTIVE APPLIANCES OF ALL DESCRIPTIONS.

SIEBE, GORMAN & CO. LTD.,

WESTMINSTER BRIDGE ROAD, LONDON, S.E.1.

Telegrams: "Siebe, Lamb, London." Telephone No.: HOP 3401 (2 lines).

The

LANCASTER

STEAM TRAPS

The most economical trap made. Will drain water at from 212° Fahr. upwards from any pressure of steam. Can be examined while working. The users of over 140,000 of the "LANCASTER" Steam Traps testify to their efficiency.

LANCASTER & TONGE LTD.

Pendleton **Manchester**

Telephone: PENDLETON 794 **Telegrams: "PISTONS," Manchester**

Acid-Proof Autoclaves

Cast Iron Chemical Plant

These are only a few of the various types manufactured. We undertake to quote to Customers' specific requirements.

DANTO-ROGEAT & CIE.

33-39 Rue des Culattes, Lyon.

London Agent:

H. SLOOG, 45 GREAT MARLBOROUGH STREET, W.1.

Telephone: Regent 2460.

Dyestuffs Monthly Supplement

Published in the second issue of "The Chemical Age" each month

Communications relating to editorial matter for the Dyestuffs Monthly Supplement should be addressed to the Editor, THE CHEMICAL AGE, Bouverie House, 154, Fleet Street, London, E.C.4. Advertisement matter, subscriptions, etc., should be sent to the Manager. The Supplement is devoted to the interests of both manufacturers and users of dyestuffs, and contributions will be welcomed.

The Dyestuffs Patent Action

THE hearing of the High Court action between Imperial Chemical Industries and the I.G., with regard to certain dyestuff patents was interrupted by the Christmas vacation. Before the adjournment of the Court, the evidence of the witnesses was concluded, and Sir Arthur Colefax, K.C., outlined the attitude of the Comptroller of Patents in regard to the matter. The hearing will be resumed on Tuesday, January 14, when counsel will address the Court. The speeches are expected to last about four days. The case is being heard by Mr. Justice Maugham, with whom is sitting Professor Arthur Smithells (president of the Institute of Chemistry) as chemical assessor, and the judgment will be awaited with considerable interest.

Fast Dyeing and Dyes

Those who had the pleasure of hearing Mr. James Morton's lecture on "The History and development of fast dyeing and dyes" at the Royal Society of Arts last February, as well as those who have seen more or less complete accounts of it, will be glad to have the complete text of the address in a little volume which exhibits excellent taste in printing. Mr. Morton's lecture fell into two parts. The first was concerned with the movement started by Sundour Fabrics, Ltd., of which Mr. Morton is the head, for the introduction of fast coloured fabrics into commercial practice. The second, which follows quite naturally on the first, describes the effort made during the early years of the war to supply from home resources the fast colours which had formerly been supplied by Germany and of which the supplies were suddenly cut off. This part describes one of the most interesting and important achievements in the field of dyestuffs chemistry ever recorded, and is well worthy of a permanent place in the literature of the subject. The author will be congratulated on having received the silver medal of the Royal Society of Arts for so notable a contribution.

A Romance

Reading the lecture again, one can easily appreciate the feelings of the author when he states that even now he has sometimes to rub his eyes and wonder whether it is not all a dream and if it is really true that he and his fellow workers have been responsible for what is now known as Scottish Dyes, with its huge buildings and railway avenues spreading over some 50-odd acres of land, dealing with thousand of tons a year of raw products to be converted into intermediates and dyestuffs of the most complicated types, by dozens of skilled chemists, with hundreds of chemical process men, and employing something like a million sterling of capital. Those who induced Mr. Morton to overcome his natural reserve and to give a detailed record of this amazing achievement deserve the thanks of all interested in chemical progress, and particularly those specially interested in domestic dyestuff production.

An Interesting Foreword

In an interesting "foreword" to the lecture Mr. Morton now writes: "The title of this paper is perhaps too comprehensive for its subject-matter. It deals only with very recent developments, but it must be remembered that the procuring of fast and beautiful colours for the adornment of himself and his materials has been one of the most absorbing interests of man from the earliest recorded times. Classical literature is full of references to colouring matters, their sources and methods of application. Within more recent times many exhaustive treatises have been printed on this subject alone, such as those delightful old volumes by Dr. Edward Bancroft, entitled 'Experimental researches concerning the philosophy of permanent colours,' first published in 1794.

"This, however, was in the days of the stage-coach and the hand-loom, when life was leisurely and things were not expected 'by return of post.' What matter if those old vegetable dyes took days or weeks to mature—it was but in the nature of things. But steam, motors, and fly-shuttles have changed all that, and the unveiling of the secrets of coal-tar, with its myriads of potential colours, arrived to meet the needs of the new times.

"But, just as any newly discovered power has its dangers for mankind till it is understood and bridled to its proper uses, so these newly-found colours, by their very abundance and ease in application, brought disaster to the textile trade for the first fifty years of their existence. So that in the beauty and quality of our products we were far behind our forefathers.

A Philosophy of Permanent Colours

"There was needed another 'Philosophy of permanent colours' in relation to those marvellous modern products, and it is from its bearing on that subject that this paper takes its title. It was obvious that if the new science was to leave us with colours less fast and less beautiful than the old vegetable dyes of our fathers, their mere abundance or ease in application would be but poor compensation.

"My paper gives the story of this new 'Philosophy' extending over the past twenty years or more. I had often been asked by friends interested in textiles to put my experiences on record, and, though the idea appealed to me as being of possible interest to others, I seemed always too absorbed in the work itself to find time to talk or write about it. But on the renewed invitation of the Royal Society of Arts to address their members on the subject I thought the occasion opportune, and this paper is the result."

New I.C.I. Colours

Imperial Chemical Industries announce the issue of two new B.D.C. colours, namely, Icyl Navy B and Chlorazol Steel Blue 6BS. Icyl Navy B, which is an addition to the B.D.C. range of Icyl colours, has been prepared for application to viscose and other artificial silks of similar dye properties. In common with the rest of the Icyl colours Icyl Navy B possesses the valuable property of giving even shades when applied to viscose of irregular dyeing properties. It yields full navy blue shades of good light fastness and is suitable for application to cotton-viscose unions. It is suitable for the production of white discharge effects with Rongalite and coloured effects in dark shades with stannous chloride. White effects are obtainable with stannous chloride in light or medium shades.

Chlorazol Steel Blue 6BS is the latest addition to the B.D.C. range of direct cotton dyestuffs. It is described as

eminently suitable for the production of medium to deep navy blue shades of very good fastness to water, perspiration, and mineral acid. This dyestuff is recommended for after treatment with metallic salts and is improved in fastness to washing by after-treatment with bichrome and in fastness to both light and washing by after-treatment with copper and bichrome. The colour is, therefore, of interest in all cases where these fastness properties are desired, and is especially useful for the dyeing of materials for bathing costumes. It possesses little or no affinity for wool or silk, and is, therefore, particularly suitable for "burl dyeing," that is, for covering the cotton in union materials.

Dyestuff Licences for December

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during December, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee :—

The total number of applications received during the month was 690, of which 562 were from merchants or importers. To these should be added 4 cases outstanding on November 30, making a total for the month of 694. These were dealt with as follows :—Granted, 650 (of which 621 were dealt with within 7 days of receipt) ; referred to British makers of similar products, 38 (of which 35 were dealt with within 7 days of receipt) ; outstanding on December 31, 6. Of the total of 694 applications received, 656 or 95 per cent., were dealt with within 7 days of receipt.

Azoic Colours for Printing

The Dyestuffs Department of E. I. du Pont de Nemours and Co., of Wilmington, U.S.A., are placing on the market a line of azoic colours for printing under the name of Du Pont Naphthanil Diazo Colours for Printing. The outstanding features of this series are extreme brilliance, their very good fastness to washing and crocking, and their ease of application. They are soluble in lukewarm or cold water and require no diazotisation, being salts containing the bases in diazotised form. When properly fixed, the colours will not mark off or bleed into the adjacent material upon rinsing and will stand repeated washings. They are, therefore, recommended for printing the finest grades of cotton goods as well as those which must stand hard wear.

A New pH Apparatus

In connection with the research upon the applications of pH control in the various branches of the textile and related industries, the Clemson College Textile School, U.S.A., has just installed a Cambridge Instrument Co.'s glass-cell hydrogen ion concentration determination apparatus in the Rayon and Dyeing section of the Division of Chemistry. Previously it has been impossible to determine accurately the pH of many industrial solutions containing various compounds of sulphur, phosphorus, arsenic, chromium, the amines, etc., owing to the so-called "poisoning" effect of these solutions upon the platinum and other electrodes used for the potentiometric pH determinations. For this reason, it has been impossible to study the hydrogen ion concentration changes in hydrosulphite solutions, including the baths used in applying the vat dyestuffs, etc. Professor Mullin has recently demonstrated that the glass cell electrode can be used for this purpose in the laboratory and has published several papers upon this subject. This, as well as other lines of investigation with the new apparatus, will be continued in the textile department of Clemson College. As this is the only glass cell pH determination apparatus in any of the American textile schools, an invitation has been extended to all those interested in that type of apparatus to inspect it at the College.

U.S.A. Colours for Next Spring

Forty-six colours will appear on the spring, 1930, Woollen Card to be issued shortly by the U.S:A. Colour Card Association. In describing the new shades, Miss Rorke characterises them as colours with a temperament, for while they are not of the intense brilliant type, they are nevertheless decidedly positive in character and possess a subtle vitality.

Greens will have a prominent place on the card in a variety of new interpretations. Bluish greens are highlighted in a range of three tones, and greens with an undertone of yellow are also included. More neutral medium greens tending to the almond cast are represented in two tones, while two smart lighter shades especially adapted to sports wear are a soft water green and a new version of Chartreuse. Another, outstanding colour family consists of blues, notably those reflecting a purplish cast, ranging from bright navies to animated medium tones. Two lighter blues for sports wear are a French blue with a rich depth, and a softer tone with a hint of mauve. A greyed blue with a violet tintex cast is another smart shade in this range.

The purple note is stressed in a rich tonality slightly rose in cast, and for sports wear there is an animated orchid hue. Other vivacious shades befitting the sports theme are the yellows, including a bright lemon hue, as well as a number of softer tones. A significant pink is a shade with considerable depth, but clouded in cast. A new creamy tint represents the eggshell family. Browns in two new interpretations will have their places in the spring mode. As the vogue for colour contrast seems assured for spring, brown used as a background colour, in combination with lighter and more animated tones, is expected to make a definite appeal. A rich chocolate tone is distinguished by a mauvish cast, while a lighter brown has a glow of rose in its depth. This last-named tone is carried out in two lighter beige shades.

Beiges still retain their place in the fashion picture, but this range appears in modernised versions. This new feeling is expressed in a smart creamy beige with a bisque undertone, while another beige with a sandy base reflects a pale pink cast. More neutral beiges with a suggestion of mauve are likewise stressed, and a yellowish, as well as a tilleul, beige for sports wear is also included.

There are two rich lively tones of red on the geranium cast. The Spanish influence is evident in a range of three animated hues shading from a light capucine with a rose cast to a rich rust tone.

A Colour Fastness Test

In an effort to establish some workable standard by which to define the quality of tub-silk fabrics, the Spun Silk Research Committee of the United States recently included in its specifications a standard for colour fastness. In drawing up specifications for the standard tub-silk, the committee was able to enlist the co-operation of retailers, buying groups, testing laboratories, dyers and printers, pattern companies, soap manufacturers, and a representative group of the most important silk weavers and converters producing tub-silks. In addition to the specifications for ware, filling, workmanship, width, and pure dye, the committee adopted the following standard of dye fastness :—

"Colours shall not fade when the fabric is immersed and agitated for 15 minutes in a ½ per cent. solution of 88 per cent. neutral soap at a temperature of 105° F."

The committee will issue specification tags to a selected list of weavers and converters who will agree to make a tub-silk constructed in a manner equal to or better than the standard established by the committee as the minimum.

Technical Developments in Dyes and Dyeing in 1929.—(I)

By L. J. Hooley

In what follows, Mr. L. J. Hooley summarises the advances made in the dyestuff-producing and dyestuff-utilising industries in 1929, as shown in published patent specifications and journals during the year.

As in 1928, an increase in the number of patents and papers dealing with dyestuffs and related matters has to be recorded. With regard to the relative amounts of attention which have been given to the various classes of dyes, the azo group comes first, followed by the anthraquinone, benzanthrone and perylene groups, while the work in other fields is normal in quantity. British firms make an excellent showing among the world's manufacturers, both in volume and variety of new inventions, and a significant feature is the increasing proportion of what may be called speculative research work. With cellulose acetate this country continues to lead, with British Celanese responsible for the larger portion of this year's work.

Anthraquinone Derivatives and Dyes

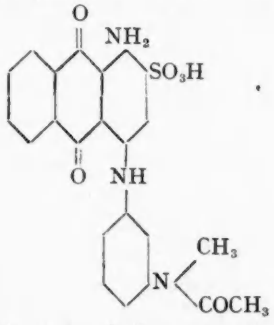
New methods continue to be evolved both for the isolation and purification of anthracene, and for its oxidation to anthraquinone. Among simple intermediates of anthraquinone, β-brominated hydroxyanthraquinones have been produced by heating the α-brominated hydroxy bodies (G.P. Applic. J. 29,921, I.G.F.A.-G.). 1-Aminoanthraquinone-2-sulphonic acid has been obtained both by sulphonation with oleum in the presence of anhydrous sodium or potassium sulphate (B.P. 289,097, I.G.F.A.-G.), and by heating the amino sulphate either alone or with oxalic acid (B.P. 299,279, I.C.I., A. Davidson, W. W. Tatum, and G. E. Watts). It may be converted to 1-amino-4-chloroanthraquinone-2-sulphonic acid, a useful intermediate for blue wool colours, by chlorinating at low temperatures, for example, below 0° C. (B.P. 302,171, I.G.F.A.-G.), no replacement of the sulphonic group taking place at this temperature. Details for the preparation of 1-amino-5-chloroanthraquinone have been given in B.P. 312,289 (S.D.L., E. G. Beckett, J. Thomas, and W. G. Woodcock).

Halogens may be removed from halogenated aminoanthraquinones by reduction with substances such as alkaline glucose (B.P. 299,333, S.D.L., W. Smith, and J. Thomas). 1-Aminoanthraquinone-2-sulphonic acid may be converted to the 1-cyano compound and thence to the carboxylic acid and the chlorocarboxylic acid by usual methods (B.P. 297,001, I.G.F.A.-G.). The production of cyano derivatives is also to be found in a number of other patents.

Anthraquinones from Benzoyl Benzoic Acids

The important route to substituted anthraquinones through benzoyl benzoic acids continues to be developed: thus, 2:4-dichlorotoluene and *o*-dichlorobenzene have been condensed with phthalic anhydride and ring-closed (B.P. 301,119, 314,804, U.S.P. 1,711,164, Newport). Tetraiodophthalic acid has been used as a source of iodoanthraquinones. Considerable development is also taking place with regard to the catalytic methods of producing phthalic anhydride and other substances by the vapour phase method, these being directed to the production and stabilisation of catalysts, new apparatus for temperature control, and methods of purification.

Among new simple substituted anthraquinones containing only one anthraquinone nucleus and suitable for dyeing



cellulose acetate or wool there are alkoxyanthraquinones which give golden yellow and greenish yellow shades on acetyl silk (B.P. 307,813, I.G.F.A.-G.); *p*-aminoarylaminoanthraquinones for acetyl silk are described in B.P. 319,905 (I.C.I., A. Shepherdson, and W. W. Tatum); and level-dyeing wool colours are obtained by condensing 1-amino-4-bromoanthraquinone-2-sulphonic acid with *m*-aminomethylacetanilide (B.P. 302,928, I.G.F.A.-G.).

Blue colours of the same type can also be made by using cyclo-pentylamine or bornylamine as bases (B.P. 282,452, I.G.F.A.-G.). α-Arylaminoanthraquinones are acridinated and sulphonated at the same time by treatment with concentrated sulphuric acid (B.P. 301,769, S.D.L., L. J. Hooley and J. Thomas).

Anthraquinone Vat Dyestuffs

Coming now to the anthraquinone vat dyestuffs, there is little new in connection with indanthrone and flavanthrone. The British Alizarine Co. have described a method for obtaining new pyranthrone derivatives by halogenating in an organic liquid with sulphuryl chloride (B.P. 306,434, B.A.C. and P. Beghin).

A fair number of patents dealing with acridone derivatives have appeared. Thus, green vat dyestuffs are obtained by the action of hydrazine on benzoylaminodiphthaloylacridones (B.P. 295,645, I.G.F.A.-G.). Chlorinated acridones are prepared through intermediates which are probably chloroacridines by treating 1-arylaminoanthraquinone-2-carboxylic acid with a substance such as thionyl chloride or phosphorus pentachloride (B.P. 295,770, B.D.C., A. Shepherdson and A. Davidson).

Pyrazolanthrones may be prepared directly from α-chloroanthraquinone by condensing with hydrazine sulphate in the presence of lime (B.P. 297,366, S.D.L., I. B. Anderson, R. F. Thomson and J. Thomas). One or two new variations in methods of alkylating pyrazolanthrone have been described, including treatment of the potassium compound of pyrazolanthrone with an organic halogen derivative in the presence of copper powder (B.P. 298,284, I.G.F.A.-G.).

Among the oxazoles and thiazoles, the anthraquinone oxazoles containing as C-substituent another anthraquinonyl group may be mentioned. These are stated to be fast vat dyes having good affinity (B.P. 299,545, I.G.F.A.-G.).

In the anthanthrone section, halogenation starting from the sulphonic acids is described (B.P. 304,613, Cassella), and sulphur dyes are made from chlorinated anthanthrone (B.P. 305,489, I.G.F.A.-G.). Vat dyestuffs analogous to anthanthrones have also been obtained from 6·6¹-diacenaphthene-5·5¹-dicarboxylic acids (G.P. Applic. J. 28,626, I.G.F.A.-G.).

A little further development has taken place in the benzodianthrone and anthradianthrone class. Thus in G.P. Applic. J. 33,097, I.G.F.A.-G., allo-mesonaphthodianthrone is converted to anthradianthrone by an energetic alkali fusion instead of the usual oxidation. This process has the advantage that since mesonaphthodianthrone is itself obtained by alkali fusion, two stages can be carried out in one.

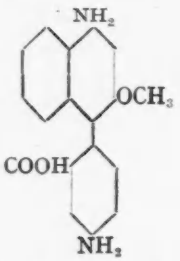
Recently the condensation of poly-halogenated vat dyestuffs with aminoanthraquinones and other amino derivatives has received considerable attention. The products are naturally very complex in structure, and the shades resulting are in general blacks, although sometimes violets and dark blues are obtained. This fact to some extent limits the possibilities of the process. As an example, α-aminoanthraquinone is condensed with tetrabromo-allo-meso-naphthodianthrone to give a navy blue.

Two papers have appeared on the sulphonation of phenanthrene, the 2- and 3-sulphonic acids being found to be the chief products (Fieser, L. L., *J.A.C.S.*, 1929, pp. 2460, 2471). 1·2-Phenanthraquinone has been prepared for the first time (*ibid.*, 1896). Meso-dihydro-, tetrahydro-, and octahydro phenanthrenes have also been described (*Ber.*, Vol. 62, 645).

Benzanthrone Derivatives

Continued activity is shown in the benzanthrone series; the developments this year are not, however, quite so much along new lines as in the last few years. As regards the production of benzanthrones themselves, reference may be made to B.P. 286,685 and 297,129, and G.P. Applic. 122,431

(I.G.F.A.-G.). Some new benzanthrone derivatives are obtained by the benzidine transformation method (B.P. 295,213, S.D.L., I. B. Anderson, R. F. Thomson and J. Thomas).



Benzyl chloride may be condensed with naphthalene and then oxidised and ring-closed to give benzanthrone or dibenzpyrenequinone. Instead of naphthalene, acenaphthene may be used, analogous products being obtained. Benzanthronecarboxylic acids can be produced by the methods of B.P 277,670 and 288,985 (I.G.F.A.-G.). In the chlorination of isodibenzanthrone, selenium is used as a catalyst (G.P. 447,556, I.G.F.A.-G.). Monochloroisobenzanthrone is prepared in B.P. 315,276 (S.C.I.B.).

The previously described method of producing black vat dyestuffs from benzanthrone derivatives is extended to substituted derivatives (B.P. 298,928, B.D.C. and S. Thornley). Two interesting surveys in the benzanthrone field have been published, namely, Luttringhaus, Neresheiner *et al.* (*Ann.*, Vol. 473, 259); and Martinet and Drobatschev (*Chem. Zentr.*, 1929, 995).

Perylene Compounds

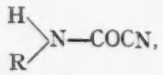
There has been something of a cessation in the number of patents on perylene derivatives—that is, perylene derivatives excluding dibenzanthrone bodies. Very highly chlorinated products can be obtained using aluminium chloride or antimony pentachloride as carrier (B.P. 288,171, Bensa).

Perylenetetracarboxylic acid may be decarboxylated in four stages by heating in neutral or alkaline solution (B.P. 272,538, I.G.F.A.-G.). The visible absorption spectra of some perylene derivatives are given by Dadieu (*Z. phys. Chem.*, Vol. 135, 347).

Indigo Dyes

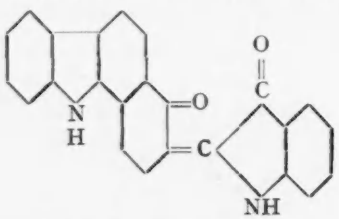
Only a moderate quantity of new work has to be noted in the class of indigo dyes. Among the halogen- and methyl-substituted indigos the four following references may be given. Fast violet shades are got by brominating 2 : 2^1-indolethionaphtheneindigos, which are monoalkylated in the indolebenzene nucleus (B.P. 295,239, I.G.F.A.-G.). 4 : 4^1-Dimethylthioindigo is said to have excellent fastness to light (B.P. 279,489, I.G.F.A.-G.). 4 : 4^1 : 6·6^1 : 7 : 7^1-hexamethylthioindigo is obtained from 5-carboxy-1 : 2 : 4-trimethylphenyl glycollic acid by the usual way, and has good light fastness (B.P. 288,544, I.G.F.A.-G.) Van de Bunt (*Rec. trav. chem.*, 1929, 12) describes the preparation of hexachloro,-octabromo- and tetrachlorotetrabromoindigos.

Isatins can be prepared from oxamic acid halides by ring closure (B.P. 308,470, I.G.F.A.-G.), also from cyclic halides of the general formula



where R is an aromatic residue (B.P. 308,980, I.G.F.A.-G.).

Black dyes of constitution similar to the following



are prepared in U.S.P. 1,706,902 (Grasselli).

The production of a considerable number of intermediates for thioindigo dyes has also been detailed in various patents.

Wool Vat Colours

Quinone anilides can be obtained from *p*-hydroxy-azo-dyestuffs on heating in aqueous solution or suspension in the presence of acid media; for example, benzene-azo-α-naphthol gives 2-anilido-1 : 4-naphthoquinone. Similarly the coupled product from metanilic acid and naphthol gives a red acid colour. The reaction may be of value for synthesising quinone anilides for wool vat dyestuffs (G.P. Applic. J. 28597, I.G.F.A.-G.).

In the preparation of dry, stable, easily-soluble preparations of leuco-compounds of vat dyestuffs, the addition of a dihydric alcohol such as ethylene glycol or an aldehyde in strong aqueous alkaline medium is recommended, followed by reduction with hydrosulphite and drying at 70–80° C. (B.P. 276,023, Geigy). Similar preparations may also be made by mixing the vat dye, hydrosulphite and a solid alkali metal alcoholate from a polyhydric alcohol such as glycol or glycerol or from a hydroxycarboxylic acid such as glycollic acid (B.P. 308,730, Geigy).

Sulphur Colours

There is little to record this year in the sulphur colours section. Brown to greenish-brown dyes are obtained by heating a mixture of *m*-tolylenediamine, dehydrothio-*p*-toluidine and *p*-phenylenediamine with sulphur at 215–240° (U.S.P. 1,675,430, L. M. Schafer). Green shades which are stated to be fast to light can be obtained by melting, with a polysulphide and a copper salt, the indophenols which are obtained by oxidation of *p*-aminophenols with alkaline ethers of *p*-hydroxyaryl-1-naphthylamine-6-, -7-, or -8-sulphonic acids (B.P. 299,909, I.G.F.A.-G.).

In the production of dinitrophenol, the nitration of benzene is accelerated by the addition of a fatty acid as catalyst (U.S.P. 1,723,761, D. B. Bradner and F. H. Beall). The use of caustic soda and arsenious oxide instead of hydrosulphite or glucose is recommended in printing sulphur colours to avoid attack on the rollers.

Dyes for Hair, Skin and Other Animal Products

A few special features in connection with the dyeing of skins, leather, etc. may be mentioned. In dyeing by methods involving the oxidation of amino compounds by means of peroxides, catalysts which act like peroxydases and determine the decomposition of the peroxides by liberating gaseous oxygen are employed (B.P. 307,480, Schueller). In the same process, an auxiliary agent such as a salt of an alkali metal may be used to assist in the rapid precipitation of the products of oxidation (B.P. 307,732). Deeper shades in fur dyeing are obtained by treatment with a semi-condensate product of urea and formaldehyde before dyeing (B.P. 301,635, Pollopas and G. Spencer). Multi-coloured effects on leather with vat dyestuffs may be obtained by partially rinsing with alkali and treatment with the vat dyestuff in a neutral or slightly alkaline bath (G.P. Applic. 27,174, I.G.F.A.-G.).

Azo dyes giving brown shades on leather are obtained by coupling two molecules of diazotised toluidine or certain other compounds with one molecule of resorcinol or resorcylic acid in the presence of caustic soda (B.P. 316,822, Bottomley and Emerson, and W. D. Earnshaw).

Azo Colours

A survey of one of the most important developments in this series, namely, the azo dyes for regenerated cellulose materials, for which the British Dyestuffs Corporation have been responsible, was given recently in the December issue of this Supplement. Most of the other main developments will be found in other sections, but a number of miscellaneous matters may be mentioned here.

In B.P. 289,098 (L. B. Holliday and C. Shaw), phthalic acid or its anhydride is condensed with aminoazo compounds; aminobenzene-azo-diphenylamine gives an orange suitable for wool, silk or cotton. Yellow wool dyes of good milling fastness are obtained by coupling tetrazotised 4 : 4^1-diaminodiphenyldi- or tri-sulphide with two molecules of a sulphonated pyrazolone (B.P. 314,673, I.C.I. and R. Brightman). In U.S.P. 1,690,783 (Grasselli), diazo compounds are coupled with β-naphthyl sulphamic acids.

A stable diazo compound of 5-nitro-2-amine-1-methylbenzene can be prepared by diazotising, and precipitating the diazo compound with hydroborofluoric acid (B.P. 316,691, I.G.F.A-G.).

(To be concluded.)

Naphthol AS Dyes on Viscose

Substantivity of the Brenthols

Naphthol AS dyes are meeting with increasing application on account of their fastness. A knowledge of the substantivity of the dye for the fibre being dyed is necessary in order that the dyer can replenish the standing bath from a stock solution, but whilst substantivities of such dyes have been measured for cotton, no figures have been published previously for viscose. Measurements of substantivities of Naphthol AS dyes on viscose have been made by Mr. T. C. Nichol, and are given (in an article contributed by him to "The Rayon Record") for the colours of this series produced by British Synthetics, Ltd.

THE constant demand for increased fastness in colouring matters of all sorts has led in recent years to a great increase in the use of the colours of the Naphthol AS series. This series includes a number of bright reds and scarlets which are extremely valuable in that they afford the only colours, with the exception of Alizarine colours, which can be included along with the Indanthrenes without diminishing the average fastness of the range. It is already well known that the colours of the Naphthol AS series are produced on the fibre by first impregnating with a solution of the sodium salt and then coupling with a diazo compound, either in the form of the base diazotised on the spot or of the stabilised diazo compound sold under the name of the colour salt.

The principal difference between this and most other methods of dyeing is that the Brenthol colour is very far from being exhausted from the dyebath, the substantivity towards

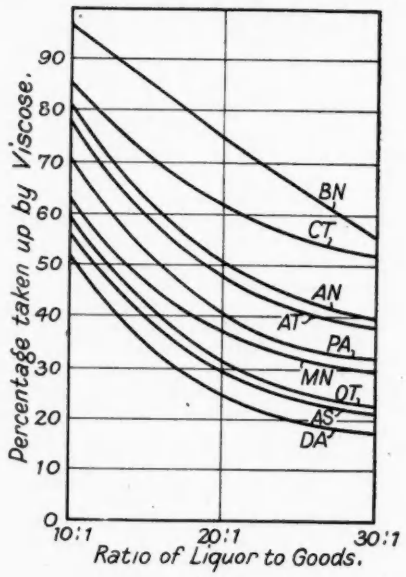


FIG. 1.

cotton of most of the members of the series being only small. In order, therefore, to avoid the very considerable wastage which would otherwise result, it is the custom to use a standing bath, replenishing it after every dyeing from a stock solution of sufficient strength to keep up the original concentration. The strength of the stock bath depends, therefore, upon the amount of colour withdrawn from the dyebath by each batch of goods, and, as this amount varies within fairly wide limits in the cases of the different Naphthol AS dyes, it is important to the dyer to know the substantivity under various conditions of every colour he uses of this class, in order that the correct amount may be added to the dyebath so as to keep its strength constant and to obtain consistent results from successive batches.

In practice, these quantities are obtained from tables furnished by the makers, which are drawn up so as to show the relations between dyebath and stockbath for the different Naphthol AS dyes and for various lengths of dye liquor. The information on which the tables are based is taken from estimations of the various substantivities made by the manufacturers, and in the case of cotton this has been done by I.G. Dyestuffs, Ltd., and published in England in the *Journal of the Society of Dyers and Colourists*, January, 1928.

These tables, however, are naturally of no use for any fibre other than cotton, as the substantivity of any Naphthol AS colour, upon which the quantities to be used in replenishing the dyebath must depend, is very different for, say, viscose from what it is for cotton. In view, therefore, of the increasing interest which is being taken in these colours by dyers of rayon, it has seemed desirable to investigate the substantivities of the various Naphthol AS colours towards rayon.

The investigations were made on the colours of this class produced, and sold under the name of Brenthol AS, etc., by British Synthetics, Ltd., a subsidiary of the British Alizarine Co., Ltd., Manchester. The results obtained are shown in the following table and also in graphic form in Fig. 1, and it will be noticed that the various Brenthols are found to be arranged in approximately the same order for viscose and cotton. The actual substantivities, however, are very much higher towards viscose than towards cotton.

SUBSTANTIVITY OF BRENTHOLS ON COTTON AND VISCOSE.
Proportion of liquor to goods 20 : 1. Temperature 25° C.

Brenthol.	Proportion exhausted on: Cotton. Per cent.	Viscose. Per cent.
Brenthol AS (AS)	11	30
,, OT (AS.D)	12	31
,, PA (AS.RL)	15	40
,, MN (AS.BS)	20	37
,, CT (AS.TR)	20	62
,, BN (AS.SW)	39	75
,, DA (AS.BR)	49	25

(The German brand marks are given in brackets for the convenience of those who are not familiar with British Synthetics' products.)

The one striking exception is Brenthol FO, which has an appreciably greater affinity for cotton than for viscose. This anomalous result was at first thought to be due to an error in the method of estimation employed, but dye trials have shown it to be correct. Another unexpected result is that for Brenthol MN on viscose, where the figures are decidedly lower than would be expected, but this Brenthol is exceptional in more than one of its properties.

SUBSTANTIVITY OF BRENTHOLS ON VISCOSE.
Temperature 25° C.

Brenthol.	Proportion exhausted at: 10 : 1 Per cent.	20 : 1 Per cent.	30 : 1 Per cent.
Brenthol AS (AS)	56	30	21
,, OT (AS.D)	61	31	23
,, MN (AS.BS)	63	37	30
,, PA (AS.RL)	71	40	32
,, AT (AS.G)	77·5	47·5	37·5
,, AN (AS.BO)	80·8	50·5	40
,, CT (AS.TR)	84	62	52
,, BN (AS.SW)	95	75	55
,, DA (AS.BR)	51	25	17·5

(The figures for Brenthol AT relate to its substantivity in 1·5 per cent. common salt solution.)

These results enable the correct strength for the feeding-up liquor to be calculated with ease. Thus taking Brenthol AS dyed at 30 : 1 as an example, the proportion of the Brenthol taken up by the goods is 21 per cent. Assuming that the viscose on removal from the dyebath takes with it its own weight of liquor, it follows that one-fifth of the Brenthol originally present must now be added to make up the loss, and it must be dissolved in one-thirtieth of the original liquor, that is, the feeding-up liquor must be six times the strength of the first bath in order to keep the concentration constant. In the case of PA a relatively stronger feeding-up solution is required, as one-third of the Brenthol is withdrawn by viscose at a 30 : 1 ratio of liquor to goods, and therefore one-third of the original Brenthol must be added in one-thirtieth of the liquor, *i.e.*, the stock solution must be ten times as strong as the original. In practice, however, viscose can be dyed in such weak solutions of the more substantive Brenthols that the dyebaths can be run off after dyeing without any considerable loss.

Effect of Hydrogen-Ion Concentration in Cherry Dyeing

By R. N. Jeffrey and W. V. Cruess

The following article, by two members of the Fruit Products Laboratory of the University of California, is reprinted from "Industrial and Engineering Chemistry." It must be borne in mind that it deals with American practice.

THREE dyes, Ponceau 3R, Amaranth, and Erythrosine, are commonly used in the colouring of maraschino style cherries. Erythrosine only is used in colouring cherries that are added to canned mixed fruits to be used for making salad, because it does not "bleed" and does not discolour the other fruits. Difficulty in obtaining rapid and uniform penetration of the cherries by the Erythrosine, however, is encountered during the dyeing process. In some cases, also, the colour imparted by Erythrosine has "bled" and stained the fruits to which the cherries were added. Preliminary experiments in the Fruit Products Laboratory of the University of California indicated that hydrogen-ion concentration is of great importance in dyeing cherries with Erythrosine and in fixing the colour. To establish more definitely the effect of this factor the experiments reported in this paper were conducted.

Rates of Bleeding

Amaranth, Ponceau 3R, and Erythrosine were compared quantitatively with respect to their rates of "bleeding"—*i.e.*, rates of dissolving from cherries prepared according to standard commercial procedure. The cherries had previously been dyed in solutions of 0·1 per cent. of each colour in cane-sugar syrups. Pitted imported Italian cherries, containing as received 1600 mg. of sulphur dioxide per kg. (1,600 p. p. m.), were used in these experiments.

To determine the comparative rates of "bleeding," the cherries were allowed to stand for 48 hours in distilled water and also in cane-sugar syrup of 20° Brix containing 0·5 per cent. citric acid. The colour in the liquid was determined by use of a Klett colorimeter and standard dye solutions. The Erythrosine gave up 0·59 part per million to distilled water and 0·10 part per million to the syrup; the Amaranth 29·1 and 12·2 parts per million; and the Ponceau 3R, 28 and 13 parts per million. Successive leachings in water and syrup dissolved much more of Amaranth and Ponceau 3R than of Erythrosine.

Varying the pH value of the leaching medium had no noticeable effect on the leachability of Ponceau 3R and Amaranth. Both leached very rapidly at all pH values used. At pH values in the distinctly acid range (4 or lower) the solubility of Erythrosine decreased markedly. Many organic and inorganic mordants were also used with the three dyes, but without effect in fixing the colour in the fruit. The effect of pH value of the medium on dissolving Erythrosine from cherries is shown in Table I. The data in Table I show that leaching of the Erythrosine was rapid at pH 6·7, appreciable at pH 4·7, and very slight at pH 3·5 and lower.

As the Erythrosine was found to respond to the reaction of the medium, further study was made on the effect of pH value on its rate and evenness of penetration into the cherries, on its fixation in the fruit, and on precipitation of the dye from water solution.

In one experiment there was added to a series of tubes of 0·1 per cent. Erythrosine solution from 0·1 to 1·0 per cent. citric acid in intervals of 0·1 per cent. and from 0 to 0·1 per cent. citric acid in intervals of 0·01 per cent. acid. In another series, rather concentrated solutions of the dye and acid were mixed to cause precipitation of the dye and were then diluted to the desired acidities. Attempts to determine the pH values of these dye solutions were not very successful because of coating of the dye on the hydrogen electrode and colorimetric pH determinations were out of the question. It is probable that the dye, being a sodium salt of a weak acid, affected the pH values to an important degree, particularly at low acidities.

Equilibrium in the two series was reached very slowly, more than two months being required. Although the results obtained were chiefly qualitative, it was found that precipitation of the dye was complete at pH 3 or lower and no precipitation occurred at pH 7, with gradation in the degree of precipitation from pH 3 to 7. Evidently the sodium salt of the dye is soluble, while the free acid (undissociated Erythrosine) is practically insoluble.

TABLE I.—EFFECT OF pH VALUE ON AMOUNT OF ERYTHROSINE DISSOLVED FROM CHERRIES.

Sample	Citric Acid Added	Final pH of Soln.	Erythrosine in Solution	
			Cherries heated to 100° C. and allowed to stand 36 hours	Cherries not heated, allowed to stand 36 hours
	Grams per 100 cc.		P. p. m.	P. p. m
1	0	6·7	33·7	27·6
2	0·1	4·7	7·7	3·75
3	0·2	*a*3·5,4·8	7·7	0·15
4	0·3	3·5	0·15	0·13
5	0·4	*a*2·6,3·4	0·05	0·05
6	0·5	*a*2·4,3·8	0·04	0·04

a The higher pH values in samples 3, 5, and 6 varied with the method used for leaching the SO_2 from the cherries. Those of higher pH value had been soaked in hot water for rather a long period; those of lower pH value had been boiled a short time in water before colouring.

In a second experiment, cherries were heated in water solution of Erythrosine solutions of the dye to which 0, 0·05, 0·15 0·25, 0·35, 0·45, and 1 per cent. of sodium bicarbonate was added. The pH values were 4·5, 6·3, 6·7, 7·5, 7·5, 7·6, and 8·0, determined after heating. Penetration of the dye was much more rapid and uniform in the alkaline solutions. The solutions containing the sodium bicarbonate penetrated the cherries much more rapidly than the plain water solution, although the high pH values caused the Erythrosine to be bluish red instead of its normal "pink-red." Acidification of the sodium bicarbonate treated specimens, however, caused the return of the normal colour.

Cherries leached with running hot water to remove sulphur dioxide were found to be considerably higher in pH value than those boiled repeatedly in water when both had reached less than 25 p. p. m. of sulphur dioxide, the pH values being 4·5 and 3·0. Other things being equal, Erythrosine should penetrate cherries leached with running hot water more rapidly than it does cherries boiled repeatedly in water.

Additional experiments proved the efficacy of the sodium bicarbonate solution of the Erythrosine for dyeing the cherries and the desirability of acidifying the syrup after dyeing in order to fix the colour.

Comparison of various concentrations of Erythrosine showed that a 0·1 per cent. solution gave as good results as more concentrated solutions.

Applying the results of these experiments to the practical preparation of maraschino style cherries showed that rapid dyeing of the cherries is accomplished by adding Erythrosine in dilute (0·3–0·4 per cent.) sodium bicarbonate solution and that practically complete fixation of the colour is then obtained by adding a dilute citrtc acid solution (approximately 0·5 per cent.).

Summary

The pH value of the cherries and that of the solutions used in the dyeing of cherries with Erythrosine greatly affect the evenness and rapidity of dyeing and the fixation or the bleeding of the colour in dyed cherries. Ponceau 3R and Amaranth are not appreciably affected by the pH value and bleed rapidly at all the pH values used in the experiments here reported. It is recommended that Erythrosine be applied in dilute sodium bicarbonate solution of approximately pH 7·5 and be fixed by dilute citric acid or other permissible fruit acid at approximately pH 3·0–3·5.

The Commercial Application of Esterified Fibres

By A. E. Woodhead, M.Sc.

Mr. A. E. Woodhead, M.Sc., (Sandoz Chemical Co., Ltd.), in the course of an interesting lecture given recently at the Chemical Society's Rooms, Burlington House, London, dealt with "The commercial application of the new esterified cotton fibres, especially having regard to dyed and finished goods." The meeting was jointly arranged by the Society of Dyers and Colourists and the London Section of the Textile Institute.

MR. WOODHEAD said that one of the first attempts made to produce a cotton which did not dye readily with direct cotton colours was due to the firm of Meister, Lucius and Bruning, who, some 25 years ago, recommended a treatment with glacial acetic acid, but the results were not exactly satisfactory, although there was a decided difference in the depth of shade when a hank of the treated cotton was dyed at the same time as a hank of ordinary cotton. In 1922, Cassells brought out a patent in which was claimed the action of aromatic acid chlorides on cotton in presence of alkali, in an indifferent solvent such as benzene, but this did not appear to have been a complete success, and two years later a further claim was made, in which a pre-treatment with caustic alkali in presence of soap or Turkey red oil, followed by steeping in an aromatic acid chloride in benzene, was said to give improved results, and these methods had been developed commercially on the Continent, the product being sold under the name of "Reserve Cotton." At about the same time the Textilewerke Horn A.-G., was working on somewhat similar lines, and in 1923 they were granted an English patent (E.P. 195,619) which had proved to be the groundwork for a commercially successful process.

Properties of Immunised Cotton

Having described this particular process, Mr. Woodhead remarked that the product obtained differed but slightly in appearance and physical properties from the original cotton used; it was to some extent mercerised, increased in weight, harsher in handle, and less lustrous, but its strength and elasticity were unaltered. The greater part of the cellulose however, had been converted into the para-toluene sulphonic ester of cellulose, as could be seen by the fact that the product, on immersion in a bath of direct cotton colour, was no longer dyed. Cotton so treated was named "immunised" cotton. Prior to undergoing the immunising process, the cotton had to be thoroughly cleansed; it had to be kier-boiled and carefully bleached, all waxy substances, pectins, colouring matters, etc., being thereby removed.

Describing the mechanism of immunisation, Mr. Woodhead said that the action of alcoholic caustic soda effected a swelling of the exterior of the cotton fibre, akin to that caused by a normal aqueous mercerisation. The interior portions of the fibre were thereby compressed, and the alkaline liquor was apparently unable to penetrate throughout the whole of the fibre. The immediate result was the production of a layer of alkalised cellulose—or sodium cellulose—surrounding a core of unaltered cellulose. When that was transferred to the sulphochloride bath, the outer layer, of course, reacted, giving an inner core of unaltered cellulose surrounded by a tube of the para-toluene sulphonic ester of cellulose. Experiments indicated that esterification, using para-toluene sulphonic chloride, proceeded to the extent of about 50 per cent. of the maximum possible.

If a relatively large amount of colour was used in dyeing, as, for example, in dyeing a black, and if the process of dyeing was unduly prolonged at a high temperature, a certain amount of colour would pass through the outer esterified layer to the central core of unaltered cellulose and would stain it, and the effect of this would be that the resist would appear stained.

Passive Cotton

So far as he knew, immunised cotton was the first esterified form of cotton to be manufactured on a commercial scale. While it would not be true to say that immunised cotton had been entirely superseded by "passive" cotton, it was a fact that passive cotton had largely replaced it. "Passive" cotton was manufactured under an English patent (280,493) granted to the Sandoz Chemical Works, and in this patent it was stated to consist of cellulose mono- and di-acetate. The most recent patent, however, made use of acetic acid, acetic anhydride and an acid catalyst. It was found that reaction did not necessarily proceed at once to the triacetate stage (the triacetate formed then dissolving in excess of the acetylation mixture, and thus permitting a further attack of unaltered cellulose), but that by a suitable choice of concentration of the reagents, time and temperature, the progress of the acetylation could be so regulated as to produce only the monoacetate, or mono- and diacetates, both of which were insoluble in excess of the acetylation mixture. In this way, the original physical form of the cotton used was unchanged after acetylation, and the original strength and elasticity remained unaltered.

Passive cotton differed from immunised cotton in several minor ways—it was softer in handle, more flexible, and was pure white in colour. Immunised cotton could also be prepared of a pure white colour, but in bulk production there were certain technical difficulties which often resulted in the final product being of a creamy tint.

Dyeing Methods

The dyeing of goods containing passive or immunised cotton followed closely in many respects the dyeing of acetate silk. Direct cotton colours, broadly speaking, left these products undyed. In certain colours, traces of basic dyestuffs occurred as by-products of manufacture, and if they were used staining of the esterified cotton naturally took place, because it was readily dyed by basic colours. Direct cotton colours could be successfully diazotised and developed on mixed material, giving shades of greater fastness to washing, but certain precautions were necessary. Sulphur colours gave a good white reserve with esterified cotton when a certan procedure which Mr. Woodhead outlined, was adopted, and vat colours also gave a good reserve; in the latter case special precautions had to be taken.

The lecturer then referred to the groups of dyestuffs which would dye both immunised and passive cottons readily, and said the most important were the disperse colours, which gave a large number of shades fast to light and very easily dyed from a bath containing only the dyestuff. Basic colours also dyed esterified cotton readily, while a further small class consisted of the Ionomine and Artisil colours.

Immunised and passive cotton were not injuriously affected by boiling water so long as no alkali was present; hot pressing or ironing did not injure passive yarn even when wet, but immunised cotton would turn black.

A very careful selection of dyestuffs had to be made in the case of esterification of goods which had already been dyed. From the dyeing point of view a brocaded or patterned fabric made from passive cotton and viscose could be exactly reversed in a material of the same design made from ordinary cotton and acetate silk.

Amidated Cotton

Mr. Woodhead explained how a saving of cost could be effected in dyeing patterned fabrics, and handed round a number of samples to illustrate his points. He also showed several samples of waterproof fabrics and garments, and concluded his lecture by a few remarks on amidated cotton, the outstanding feature of which, he said, was its power of dyeing with ordinary acid colours from a neutral or acid bath, just as in the case of wool. By weaving cloth from a warp mainly of ordinary cotton with esterified cotton stripes, and by using a weft composed in part of mercerised cotton and in part of amidated cotton, an almost endless range of colour combinations could be dyed from a single dye-bath by using mixed dyestuffs of various groups. Another side of the question, however, was what the waste dyer of Lancashire and Yorkshire would say if the time came when the waste he had to dye contained certain amounts of chemically altered celluloses. At present life was made a burden to him by acetate silk alone, so what it would be with several more eccentrically-dyeing fibres only he would be able to say.

Dyestuffs Markets: The Month's Business in Review

From Our Own Correspondents

Lancashire

If hopes were entertained of an improvement in the textile trade during December, these, so far as dyeing and printing are concerned, have not been justified by the events. Trade generally is exceedingly quiet, and the outlook is not bright.

Dyers and printers during the past year have been subjected to greater pressure than ever in the matter of guarantees of fastness. The dyer, knowing that "unfadeable" dyes in the strict sense of the word are not yet possible of achievement, is placed in the dilemma of refusing to give the required guarantee, and thus losing the business, only to see it taken by dyers here or abroad who interpret the phrase, or of rendering himself liable to claims out of all proportion to the value of the dyeing at some undefined future date, perhaps years hence. For the protection of all parties concerned, it is eminently desirable that standards should be set up with some relation to the actualities of the situation.

Attempts to limit the guarantees to periods of, say, 12 months, have been made both here and in America, where, it is said, a standard ticket indicating its degree of fastness is attached to the dyed or printed fabric. It is, however, unlikely that much progress in the commercial side of this question can be made until the technical problems connected with the determination of fastness have been solved. Even the meaning to be attached to the word "fast" itself in connection with coloured textiles has no common acceptance, as has been clearly shown in a recent case in the Law Courts. It is, therefore, to be hoped that the Fastness Committee set up by the Society of Dyers and Colourists will be supported in every way by all sections of the community interested in this question of fastness.

General satisfaction has been caused to colour users in the North by the transference of the dyestuff selling organisation of I.C.I. from London to Manchester. This move is presumably part of a policy of obtaining and maintaining the closest touch with the dye user—a policy which the German makers have consistently followed with great success.

Scotland

The year which has just passed has only been a moderately good one in the textile dyeing and finishing trades. There have been the difficulties of the cotton strike, the General Election and the fall in financial values, and although none of these had direct and immediate effects on the Scottish trade, they have not been without a depressing influence, so that possibly without them the year would have been slightly more satisfactory than the previous one.

At the moment, prospects seem fairly steady. During the last month, employment in the dyeing and printing sections in the Glasgow and Paisley district was fairly normal. Business has been pretty good in the carpet trade in Scotland. Only a minority of tweed manufacturers are running at full strength, and a quiet time is now expected until the 1930–31 season's orders begin to come along.

A suggestion has been made by the Wool Publicity Committee of the Grazing Federal Council of Australia in connection with the "Use More Wool Campaign"; this is that suggestions should be submitted by the Research Councils in this country with regard to possible methods of promoting the Committee's plans, when the Committee may be prepared to give these financial backing.

Vat Colours on Loose Wool

The increasing demand for colours dyed on loose wool to withstand both acid and alkaline milling, as well as being fast to light, has led, the *Textile Colorist* states, to much attention being paid to vat dyes for this purpose.

The anthraquinone vat dyes, on account of the very alkaline dyebaths necessary for the solution of their leuco compounds, are not at all suitable for wool, although it has been claimed that damage to the fibre may be avoided by the addition of protective colloids, such as glue, to the dyebath. The leuco compounds of the indigoid dyes are applied from a bath containing very much less free alkali, and have, in consequence, been used to a considerable extent on wool where a high degree of fastness is called for. Yarn or piece dyeing with these colours offers no great difficulty, but on loose wool matching is by no means easy, particularly in pale shades.

Within the last few years a wide range of esterified leuco indigoid and leuco vat colours has been put upon the market; the indigoid derivatives under the name of Indigo sols, the anthraquinone colour derivatives under the name of Soledons. These bodies are applied to wool very much in the same way as acid dyes of an easily levelling character, and are converted into the actual vat dyes by a mild oxidation subsequent to the dyeing. The wool or slubbing is packed evenly into the dyeing machine and carefully wetted out with water at 100° F. to 110° F., with the addition of a little acetic acid, should any alkali be present from the scouring bath. If the dyeing machine contains any parts made of copper, about 1 per cent. of ammonium sulphocyanide must be added to prevent the formation of stains. The dyestuff, previously dissolved in hot water, is added next, followed by ammonium sulphate, 1 per cent. to 10 per cent., according to the depth of the shade being dyed, followed by 0·5 per cent. to 3 per cent. of acetic acid (40 per cent.).

In the course of half an hour the dye-liquor is brought to the boil, and further quantities of acetic acid added till the bath is exhausted, which should require another 15 to 20 mains. To make sure that no further colour remains in the liquor, a small sample is treated in a test-tube with a few drops of 10 per cent. sulphuric acid, and one drop of 1 per cent sodium nitrite solution, and then warmed in a boiling-water bath to 195° F. The free nitrous acid will oxidise any leuco ester still present to the insoluble dyestuff, and a coloured precipitate will be thrown down, in which case more acetic acid is added to the machine, and another test made for exhaustion after a further 15 mins. run.

When the dyeing is completed cold water is run in, the circulation being maintained meanwhile until the temperature has been reduced to 85° F. Sodium bichromate is next added, equal in weight to the dyestuff used, but never less than 1 per cent. After circulating for another quarter of an hour, 7 per cent. of sulphuric acid, previously diluted with water, is allowed to run in slowly, and the temperature raised again to 180° F., at which point it is maintained for half an hour. A considerable economy, both of oxidising material and of time, may be effected by running off as much liquor as possible before adding the bichromate, as the development of the colour takes place much more easily and quickly in a short bath.

Finally, the wool is well washed in the machine, and, if necessary, the final traces of acid are neutralised by a treatment with soda ash at 85° F., followed by another wash with cold water.

Level dyeings are produced without difficulty in all classes of woollen material by means of these solubilised vat dyes. Should unevenness occur, it may generally be ascribed to insufficient neutralisation before adding the colour, or to excess of acetic acid at the commencement of the dyeing operation.

Spanish Production of Acetone

The production of acetone, butanol, butyl acetate and methanol in Spain is limited. Acetone is produced to some extent, especially by the companies Foret, S. A., of Barcelona, and El Irati, of Pamplona. Imports of acetone are classed with "methylene" and methyl alcohol. During 1927, the last year for which official statistics are available, these products were imported in the following quantities: Germany, 452 metric quintals, valued at 114,808 pesetas; United States, 157 metric quintals, valued at 39,878 pesetas; and Great Britain, 145 metric quintals, valued at 36,830 pesetas. Butanol and butyl acetate are also produced locally. Butyl acetate is imported under the classification "Esters not expressed," of which total imports in 1927 amounted to 1,956 kilos, valued at 48,900 pesetas.

Dyestuffs Monthly Supplement

Published in the second issue of "The Chemical Age" each month

Communications relating to editorial matter for the Dyestuffs Monthly Supplement should be addressed to the Editor, THE CHEMICAL AGE, *Bouverie House, 154, Fleet Street, London, E.C.4. Advertisement matter, subscriptions, etc., should be sent to the Manager. The Supplement is devoted to the interests of both manufacturers and users of dyestuffs, and contributions will be welcomed.*

I.C.I. Dyestuffs Group

ATTENTION is drawn by our Lancashire correspondent in his monthly market notes to several interesting staff rearrangements in connection with the Dyestuffs Group of Imperial Chemical Industries. The sales headquarters, it is interesting to hear, have been restored from London to Manchester—a centre obviously in much closer touch with textile industries than the capital. This step will undoubtedly be welcomed in Lancashire and the north, where opinion has never been enthusiastic about the concentration of everything in London, whether dyestuffs or anything else.

A Batch of New B.D.C. Colours

Imperial Chemical Industries, Ltd., announce the issue of five new and important B.D.C. colours, namely, Solochrome Yellow 3GS and Red 6BS, Lake Orange RS, Monolite Fast Red GS Paste and Lumps, and Lissamine Violet 6BNS.

Solochrome Yellow 3GS is an addition to the B.D.C. range of chrome colours. It is described as a greener and brighter brand of the Alizarine Yellow WS type, and as suitable for all branches of fast wool dyeing, particularly for loose wool and slubbing where good general fastness is required. It is of interest for the dyeing of pieces owing to the fact that it leaves cotton effect threads unstained. It is also suitable for the various types of circulating machines, as it possesses good solubility and levelling power. It also has good level dyeing properties when applied by the chromate (metachrome) process, and is particularly recommended for use as the yellow component in mode shades and for shading purposes.

Solochrome Red 6BS, also an addition to the same range of colours, is an entirely new chrome dyestuff giving brighter chrome reds than hitherto obtainable. It gives a much bluer and brighter shade than Solochrome Red ERS. In view of its excellent fastness to milling and levelling power, it is specially suitable for dyeing loose wool, slubbing and piece goods. It is recommended in the dyeing of piece goods where it is desired to leave cotton and viscose rayon effect threads white. It possesses good solubility and is suitable for application in the various types of circulating machines.

Lake Orange RS is the latest addition to the B.D.C. range of water soluble lake making dyestuffs, and is intended for manufacturers of printing ink colours, wallpaper colours, and paper surfacing colours. The outstanding features are its bright fiery orange shades and its good fastness to lime. It gives the best results when precipitated with barium chloride.

Monolite Fast Red GS Paste and Lumps is an addition to the B.D.C. Monolite series of dyestuffs for lake making, and is of particular interest to manufacturers of lakes for oil paints, water paints, printing and lithographic inks, paper surfacing, artists' colours, etc. The shade is similar to that given with the best yellow shade vermilion. It is distinguished by its excellent all round fastness properties, which render it highly suitable for uses where fastness to light and to atmospheric influences are essential.

Lissamine Violet 6BNS, a new addition to the B.D.C. range of acid colours, is of interest for all purposes where brilliancy of shade is required, as for the production of bright navy shades on dark coloured shoddy materials stripped with chrome and vitriol. Carbonised materials may be dyed with this colour owing to its stability in the presence of strong acid dyebaths. Cotton effect threads in woollen pieces are left white. Other valuable properties are that it withstands a light milling and in addition it may be applied from a neutral dyebath so that it is of interest to dyers of union materials. When applied from a strongly acid dyebath it possesses the valuable property of covering faded material, making it particularly valuable to garment dyers.

An Accelerator Patent Extended

In the Chancery Division, on Wednesday, Mr. Justice Luxmoore extended for two years from the date of expiry, February 19, a patent granted to Stanley John Peachey in 1914 for an accelerator for vulcanising. It was stated that since the war the patentee had received, on an average, about £1,300 a year, and that in 1922 he received a capital sum of £2,000 from the British Dyestuffs Corporation.

Dyestuff Licences for January

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during January, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee:

The total number of applications received during the month was 647, of which 572 were from merchants or importers. To these should be added six cases outstanding on December 31, 1929, making a total for the month of 653. These were dealt with as follows: Granted, 611 (of which 594 were dealt with within seven days of receipt); referred to British makers of similar products, 24 (all dealt with within seven days of receipt); outstanding on January 31, 18. Of the total of 653 applications received, 618, or 95 per cent., were dealt with within seven days of receipt.

Progress with Colour Council Scheme

Those who attended the inaugural meeting of the British Colour Council scheme in London last October will shortly have before them final proposals for launching the project. Reports have been received from sub-committees set up to draft a constitution and rules and make arrangements for suitable premises and staff. It is proposed that the council should be registered as a company limited by guarantee, without share capital, and that London offices should be rented as headquarters. Practical operations in collecting information as to world colour tendencies is, however, not expected to be begun before next autumn at the earliest. The business to be considered at the second full conference of the parties interested in the scheme will be largely confidential, and mainly concerned with financial arrangements.

America's Perkin Medallist

Dr. Herbert H. Dow, founder and president of the well-known American firm, the Dow Chemical Works, was recently presented with the Perkin Medal for 1929 at a joint meeting in New York of the Society of Chemical Industry, the American Chemical Society, the Société de

Chemie Industrielle and the American Electrochemical Society. The presentation address was delivered by Professor M. T. Bogert. In acknowledging the medal, which represents America's tribute to the great English chemist who produced the first coal-tar dye, Dr. Dow reviewed the more important stages in the development of the various chemical processes as carried out at the Dow Chemical Works, which have grown from a small plan, originally for the manufacture of a few compounds of chlorine and bromine from the extensive salt deposits in the neighbourhood, to one which to-day produces more than 175 individual chemical compounds, including many commercial chemicals, medicinals, dyestuff intermediates, indigo and related dyes, and a number of very important alloys.

What are the Primary Colours?

Dr. Drevor, in a paper presented at Edinburgh on this subject, pointed out that, while the artist and the physicist agreed in holding that there were three primary colours, the artist named red, blue and yellow, while the physicist named red, blue and green. Colour phenomena, he suggested, were really phenomena in the fields of physiology and psychology, rather than physics. Both physiologists and psychologists held that there were four pure colours—red, blue, green and yellow. If they were to use the term "primary" of colours it ought to be used of all four. In any case, none of the physicist's criteria of what were "primary" colours could be accepted as valid, since all the hues of the spectrum could be produced by the mixture of several groups of these colours, and there was no spectral hue that could not be produced by the mixture of two other spectral colours.

Sundour Fabrics Developments

Following on the recent transfer of Scottish Dyes Works from Carlisle to Grangemouth, Messrs. Morton intend, by a gradual process, to transfer the carpet-weaving and manufacturing section of their extensive works in Dentonhill to their Caton factory at Lancaster, where the manufacturing of Axminster carpets is carried on. The object of the transfer is further to co-ordinate the various branches of the firm. The whole of the works in Carlisle will eventually be confined to the manufacture of Sundour and other fabrics, and the city will not be adversely affected by the change. It is understood that some of the workers in the carpet-making will be transferred to Lancaster, and that other labour will be absorbed in the Carlisle works.

Dyeing Still an Art

Monsieur L. Blin Desbleds, a French colour technologist, in a work just issued on "Exact Colour Matching and Specifying" (Technological and Industrial Service, Paris, 4s., pp. 116), supports the view that, in spite of technological advances, dyeing is still an art. Even to-day, he says, neither can the buyer of dyed goods specify exactly a definite colour that he requires, nor can the dyer guarantee any limits within which he can reproduce the exact shade of a sample submitted to him. In fact, although it has been practised for thousands of years, dyeing is still considered as an art; and, as such, it has hitherto escaped from the precision of scientific measurements. It is so much open to personal appreciation that the exact colour of a dyed job, as seen by the eye, may form the subject of endless disagreements. Any dyer knows that a match which seems exact to him may very well be adversely criticised by someone else. Both he and his critic may be perfectly honest in their views; and, in fact, each one may be right according to his vision; and it was such a circumstance which led Voltaire to say wittily that "regarding tastes and colours there can be no discussion."

Exact Colour Specifying Now Possible

If, however, the author proceeds, colours were measured scientifically, and if colour matching were based on well-defined scientific principles, quite a different meaning would be attached to the saying that "with regard to colours there can be no discussion." To-day it is possible to draw up colour specifications with scientific exactness and to settle the question of a colour match without any possibility of dispute or discussion. Of course, the need for a scientific method of colour measurement and notation, which would permit any colour to be exactly defined and reproduced, whenever wanted, has long been recognised. Indeed, many attempts have been made to solve the problem, and numerous ingenious devices have, from time to time, been invented and marketed to this end. No apparatus, has, however, until recently, been produced which is sufficiently simple and accurate to be of real value to the dyer in his daily work.

Objections to Scientific Instruments

The practical dyer has two main objections to most colour-measuring scientific instruments. In the first place, the instruments, which, in the past, have been proposed to him, were, generally speaking, too complicated, and their use too delicate. Those instruments demanded, besides, special training to interpret correctly the results they gave. In the second place the dyer found it difficult, if not impossible, to reconcile, in many instances, the scientific exigencies of the physicist, who sees in colour merely light modified by a surface or radiated from an object, with those of the physiologist who registers but a sensation felt by the eye. And it is because it is, to-day, possible to satisfy, in a very simple manner, the requirements of both the physicist and the physiologist that the author claims that the time has come when colour matching can be placed on a truly scientific and exact foundation.

Colour Lakes for the United States

Of colour lakes the United States imported 57,073 lb. (value $26,802) in 1928, and 26,083 lb. (value $15,775) in 1927. The following table gives a summary of the dyes imported in 1928 and 1927, classified according to method of application. There is also shown the percentage of the total imports for each class of dyes for those two years. With the exception of the sulphur, colour-lake and spirit-soluble dyes, there has been a marked increase in the imports of each class of dyes. The proportion that each class represents of the total imports shows slight variation for the two years:—

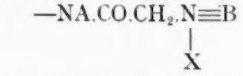
	1928.		1927.	
	lb.	Per cent.	lb.	Per cent.
Acid dyes	992,767	18·56	654,729	15·47
Vat dyes	2,315,494	43·30	1,730,967	40·89
Mordant and chrome dyes	476,961	8·92	488,605	11·54
Direct dyes	916,858	17·14	721,342	17·04
Basic dyes	424,969	7·95	334,526	7·90
Sulphur dyes	125,350	2·34	137,864	3·26
Spirit-soluble and colour-lake dyes	86,075	1·61	134,778	3·18
Unidentified, unclassified special dyes	9,753	·18	30,235	·72
	5,348,227	100·00	4,233,046	100·00

Technical Developments in Dyes and Dyeing in 1929.—(II)

By L. J. Hooley

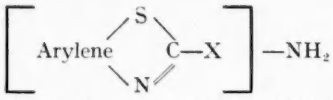
In last month's Dyestuffs Supplement, Mr. Hooley began an article summarising last year's activities. This article is concluded below.

STRONGLY basic azo dyestuffs containing the group



are obtained by, for example, treating an unsulphonated aminoazo dyestuff successively with chloroacetyl chloride and a strong base (B.P. 295,032, Geigy).

Azo dyes containing a quaternary group can be made by coupling a diazotised unsulphonated aminoarylene thiazole compound of the formula

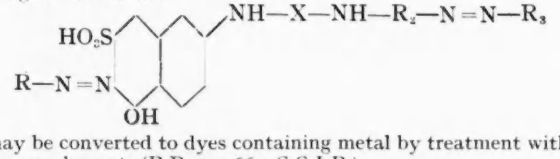


with an unsulphonated azo component and then treating with an alkylating agent such as *p*-toluenesulphonic acid methyl ester. The quaternary group appears to be formed at the nitrogen atom in the thiazole ring (313,293, I.G.F.A.-G.).

In 307,965 (I.G.F.A.-G.), the production of alkali metal salts of nitrosamines is described, by transforming the diazo salt into the syn-diazotate and then converting to the anti-diazotate, using special temperatures and special concentrations of alkali.

Azo Chrome Colours

This class of compounds, in which the chromium or other metallic mordant is incorporated with the dyestuff before use, continues to be extended. The new developments during the year are, however, mainly of a secondary nature. In B.P. 296,680 (S.C.I.B.), the chromium compounds are obtained by baking the azo dyestuff with the chromium salt. In B.P. 307,871 (Kuhlmann), the chromium is used in the form of a salt of an aromatic organic acid. According to G.P. 453,949 (I.G.F.A.-G), dyestuffs containing chromium and derived from aminophenols can be subjected to ordinary chemical processes, without destruction of the metal complex—for instance, nitro groups may be reduced or amines acylated. Substances of the general formula



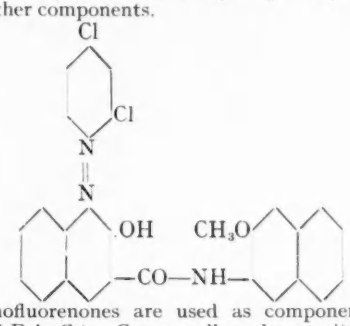
may be converted to dyes containing metal by treatment with the usual agents (B.P. 315,665, S.C.I.B.).

The previous process, where only sufficient chromium was used to provide one atom for each chromable group, can be modified by using more chromium but a lower temperature (B.P. 316,231, I.G.F.A.-G.). Complex metal azo dyes suitable for leather consist of the chromium or copper compounds of the dyes of nitro- or chloro-diazotised *o*-aminophenols coupled with substituted *m*-phenylenediamines. In B.P. 306,559 (I.G.F.A.-G), copper ammino complex azo compounds are obtained by coupling diazo-, diazoazo-, or tetrazo- compounds containing carboxyl, hydroxyl, or carbonyl groups in the *o*-position to the azo linkage with a coupling component, in the presence of a water soluble complex nitrogenous copper compound.

Azo Development Colours

This class continues to be of considerable importance, and the search for new members and components continues. Blue shades are obtained by coupling 2 : 3-hydroxynaphthoic acid 2^1-methyl-5^1-isopropyl : 1^1-anilide with a diazo compound of a base such as 4-aminodiphenylamine (B.P. 311,400, I.G.F.A.-G.). Blue shades are also obtained by coupling a 4-diazo-N-nitrosodiphenylamine with an arylide of 2 : 3-hydroxynaphthoic acid. The shades are in the first case garnet to violet, changing to blue on removal of the nitroso group. The diazo-nitrosodiphenylamine compounds are formed by adding two molecules of nitrite to one of amino-diphenylamine (B.P. 313,865), I.G.F.A.-G.). The preparation of nitroso-diazo solutions such as these is also described in 307,890 (I.G.F.A.-G.).

3-Alkoxy-β-naphthylamines of 2 : 3-hydroxynaphthoic acid have the advantages of good affinity for cotton, so that the padded fibre may be rinsed to give fast-to-rubbing colours, and also of stability in concentrated solutions, so that no formaldehyde is necessary in the padding bath. Examples are given of coupling with 2 : 5-dichloroaniline (orange red) and a large number of other components.

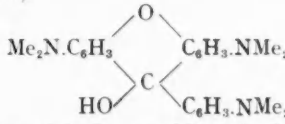


Diazoaminofluorenones are used as components in B.P. 298,697 (I.G.F.A.-G.). Green yellow dyes suitable for oil pigments are obtained by coupling diazotised *p*-aminoacetophenone with acetoacetic arylamide (B.P. 307,104 I.G.F.A.-G.). Solutions of arylides may be stabilised by the addition of sulphonated fatty acids obtained from oil fats (B.P. 307,777, I.G.F.A.-G.). Cyano derivatives are used as coupling components in B.P. 301,410 (I.G.F.A.-G.), thus 4-cyano-*o*-toludine gives a red with the 4-chloro-*o*-anisidide of 2 : 3-hydroxy naphthoic acid.

Basic Colours

The number of patents and new developments in the basic colour group is slightly larger this year. Blicke and Smith (*J.A.C.S.*, 1929, p. 1865) prepare 4-fluoro-, 4-chlor-, 4-bromo-, 4-iodo-, and 3-iodo-phthalic anhydrides and use them for the production of phenolphthaleins. Basic and acid dyes of the Rhodamine series are obtained by condensing a fluorescein dihalide with an unsulphonated aminophenol (B.P. 303, 243, I.C.I. and L. J. Allchin).

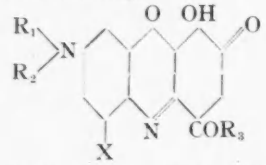
Sen and Kar (*J. Indian Chem. Soc.*, 1926, 53) have prepared aldehydophenolphthalein by the Reimer-Tiemann reaction. The 3 : 7-tetraalkyldiaminoxanthenes are converted to xanthiones with sulphur in boiling xylene and then into xanthones by boiling with acid. This is the first commercially feasible method of making these xanthones (B.P. 314,826, I.C.I., E. H. Rodd and H. H. Stocks). These xanthones may be condensed with aromatic halogen compounds in the presence of sodium to give carbinols (B.P. 314,825, I.C.I., E. H. Rodd and H. H. Stocks).



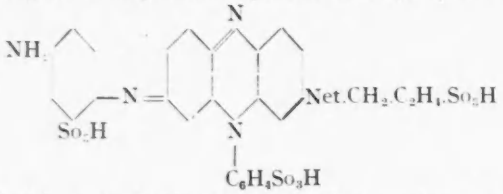
The alkylation of hydroxyacridines is described in B.P. 317,869 (I.G.F.A.-G.). Salts of basic dyes can be converted to products of bactericidal or therapeutic value by treatment with phenolic bodies (B.P. 295,605, R. W. French and W. C. Holmes). In connection with the use of acridine derivatives for pharmaceutical purposes, the process of G.P. 440,771 for isolating acridines from anthracene oil is of interest. Acridine is the only constituent which forms an addition compound with sodium bisulphite. By this method the pre-war price of £20 per kg. is stated to have been reduced to 6s. per kg.

Hydroxyphenazines are converted to hydroxycarboxylic acids by treatment with alkali bicarbonate, and then on thionation give sulphur colours (B.P. 299,152, R. W. Pope and M. Wyler). Condensation products of the benzodiazine series are described in B.P. 287,179 and 288,159 (I.G.F.A.-G.). The production of gallocyanines of the general formula shewn

below from methyl substituted alkylanilines is given in B.P. 301,329 (Durand and Huguenin).



Direct dyes suitable for the viscose silks are obtained by phosgenating azine dyes; for example, the product shown below gives a bright blue dye (B.P.296,803, B.D.C. and W. A. Silvester). In F.P.629,669, oxazines are converted to azines by heating with primary arylamines.



The fastness to light of complex phosphotungstomolybdic acid lakes of basic dyestuffs is improved by a boiling treatment (B.P.307,436, I.G.F.A.-G.).

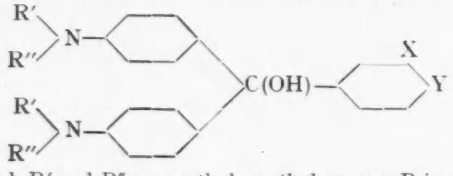
To avoid the use of mordants in dyeing with basic colours, the free colour base is treated with an aromatic hydroxy acid, for example, tannin or salicylic acid, in the presence of a mineral acid; the resulting product can then be dyed without steaming or mordanting (F.P. 620,746, Du Pont). Mordants for basic dyes may be obtained by the action of sulphuric acid on fatty acids, high boiling distillation products of petroleum, etc. (B.P. 304,608).

Triarylmethane Colours

As usual, there is only a small number of patents in this series. Spirit-soluble salts of these dyestuffs have been made by adding hydroxynaphthoic acids to the hydrochlorides of the dyestuffs (B.P. 298,101, I.G.F.A.-G.) Bases of the di- and tri-arylmethane series, either alone or mixed with mineral salts, sulphite-cellulose liquor, etc., are stated to be useful for cleaning metals from rust and for use in pickling baths, etc. (B.P. 313,135, S.C.I.B.)

In the production of dyestuffs by introducing phenyl, tolyl and naphthyl groups into pararosaniline by heating with aniline and a talyst, the reaction proceeds much more smoothly, and an increased yield is obtained if anisidine or phenitidine is substituted for aniline; the products also sulphonate more readily, giving valuable greenish-blue dyestuffs. (B.P. 308,906, I.C.I., E. H. Rodd and F. L. Sharpe.)

Green dyestuffs for acetyl silk consist of oxalates of unsulphonated triarylmethane derivatives of the formula



in which R′ and R″ are methyl or ethyl groups, R is an alkyl group, and of X and Y at least one is an alkyl or alkyloxy group (B.P. 297,897, B.D.C., L. G. Lawrie, F. W. Linch and E. H. Rodd).

Cellulose Acetate

This year's material under the above heading is very voluminous, and includes, in addition to a large number of patents dealing with the selection of dyestuffs for acetyl silk, others covering aspects such as hydrolysing, mercerising, weighting, lustreing and delustreing of cellulose acetate and similar organic derivative of cellulose. In addition, various methods have been published for producing pattern effects, and for discharging and reserving colours.

Of interest from the theoretical point of view is a further paper by Kartaschov and Farine (*Helv. Chim. Acta.*, Vol. II, 813). Solubility determinations in cellulose acetate and in alcohol of anthraquinone derivatives show, for example, that nuclear methyl groups or methylamino groups are the most effective, and that the tetraminoanthraquinones are less soluble than the diaminoanthraquinones.

The patents dealing with mercerisation, weighting, etc., cannot be referred to in detail. For the production of pattern effects, reference may be made to B.P. 301,567, 309,194, 309,568, 310,773, 310,844, 311,306, and 314,501. As regards discharging, a chlorate with a ferricyanide or vanadate as catalyst is recommended in B.P. 312,655 (Brit. Celanese and G. H. Ellis), while black and navy blue developed dyeings, which can be discharged white, are described by Fischer (*Textilb.*, English Edition, 10, 47). The difficulty of discharging with sodium hydrosulphite owing to poor penetration can be overcome by using resorcinol (L. Diserens). Acetyl silk may be reserved by printing with a wax or fat, and then dyed with a diphenyl black and developed to give black and white effects (B.P. 311,467, I.G.F.A.-G.). The use of organic solvents for dyestuffs is dealt with in B.P. 308,173, 314,208, 313,450 and 313,451 (Brit. Celanese *et al.*). Black dyeings are obtained by the oxidation method from amines, etc., in B.P. 298,699 and 313,435 (Brit. Celanese *et al.*), and B.P. 314,651 (I.C.I. and E. A. Speight).

Coming now to new dyestuffs, these belong largely to the azo class. For details, the original patents may be consulted, including B.P. 284,652, 299,343, 300,929, 301,564, 306,981, 310,779, 310,827 and 311,433. In addition, unsulphonated thiazoles are used in B.P. 306,981 (Brit. Celanese, G. H. Ellis and H. C. Olpin); thioalkylether-anthraquinone derivatives in B.P. 308,242 (I.G.F.A.-G.); certain selected nitro compounds in B.P. 305,560 (Brit. Celanese, G. H. Ellis and H. C. Olpin); and Malachite Green dyestuffs containing in the aldehyde nucleus an alkyl group in position 2 and an alkyl or alkoxy groups in position 4 and/or 5 (B.P. 297,897, B.D.C., L. G. Laurie, F. W. Linch and E. H. Rodd).

Immunised Cotton

Maleic anhydride has been used for making cotton immune to direct dyestuffs, their affinity for basic dyes being at the same time increased (B.P. 315,434, S.C.I.B.). In immunising with acetic anhydride a prior treatment with copper sulphate may be given (B.P. 315,435, S.C.I.B.).

Application

The number of publications in connection with application is very considerable. They include the production and preservation of dyestuffs in finely divided form. In B.P. 297,076 grinding is carried out in the presence of sulphonic acids or their salts (I.G.F.A.-G.), while in B.P. 293,896 (B.D.C., H. J. Hailwood and A. Shepherdson) another finely divided and harder substance is added to help the grinding. A dispersed dye paste can be mixed with the products obtained by action of hot alkali on lignin sulphonic acid (B.P. 301,549, B.D.C., H. Adams and A. Shepherdson). Polychloronaphthalenes may also be used in making up pastes or suspensions of vat dyestuffs. The settling out of dyestuff pastes, especially of vat dyestuffs, can be prevented by the use of a small quantity of a natural colloidal clay such as bentonite.

In connection with the use of alkyl aromatic sulphonic acids in F.P. 623,704, cotton effect threads in woollen material are left white by the addition of these to the bath; the same wetting agents can be used in the production of oxidation dyes on the fibre (U.S.P. 1,684,881, I.G.F.A.-G.). Cellulose materials which do not crease are obtained by mercerising and then impregnating in the wet condition with a synthetic resin (B.P. 304,900, Tootal Broadhurst Lee, R. P. Foulds and J. T. Marsh).

There is not room to mention the various processes for producing multi-colour, imitation and other effects. A method of colouring rubber with vat dyestuffs is described in B.P. 304,376 (I.C.I., A. J. Hailwood, W. S. Naunton and A. Shepherdson). With regard to printing, the use in the preparation of the printing pastes of ethanolamines (B.P. 285,041, Du Pont), soaps (B.P. 341,761, I.G.F.A.-G.) and sodium aluminate, and trisodium phosphate (G.P. Applic., 118,724, I.G.F.A.-G.), may be cited.

Fast prints can be obtained by applying an alkali solution of an aryl thioglycollic *o*-carboxylic acid amide, steaming and oxidising (B.P. 299,069, I.G.F.A.-G.). Formulæ for printing pastes on cotton with vat colours containing Formosul are given by F. E. Hager (*J.S.D.C.*, 192).

Finally, in an ageing machine for fabrics dyed with vat dyestuffs, the steam is kept wet by supplying water at various points in the immediate vicinity of the fabric.

Basic Intermediates for Dyestuffs: No. XXXIII.—The Naphthol Sulphonic Acids.—(I)

By "Consultant"

So far, the naphthol sulphonic acids have not been dealt with in this series of articles, the intention being to devote a series of three papers to these most important intermediates. The naphthol sulphonic acids form a group of components for azo dyes that are almost universally used in synthetic dyestuffs practice, and which are at the present time almost indispensable. Before dealing in detail with the methods used in actual practice for the synthesis of these compounds, it will be necessary to give a short account of the group as a whole.

The sulphonic acids of β-naphthol are shewn in the table below, in which the commercially important members alone are mentioned :—

β—Naphthol Sulphonic Acids.

Monosulphonic Acids.	OH	SO_3H	Commercial name.
	2	6	Schaeffer's β-acid.
	2	8	Crocein acid.
	2	5	Gamma-mono acid.
	2	7	F- or δ-acid.

Disulphonic Acids.	OH	SO_3H	SO_3H	
	2	3	6	R-acid.
	2	3	7	δ-Disulphonic acid.
	2	4	8	Disulphonic acid-C.
	2	6	8	G-acid.

Trisulphonic Acid.	OH	SO_3H	SO_3H	SO_3H
	2	3	6	8

whilst the sulphonic acids from α-naphthol may be summarised as follows :—

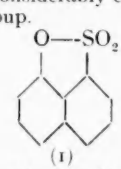
Sulphonic Acids of α-Naphthol.

Monosulphonic Acids.	OH	SO_3H	Commercial name.
	1	2	Schaeffers α-acid.
	1	4	Neville and Winter's acid.
	1	5	L-acid.
	1	8	Schöllkopf's acid.

Disulphonic Acids.	OH	SO_3H	SO_3H	
	1	2	4	Acid for Martius' Yellow.
	1	3	8	ε-Disulphonic acid.
	1	3	4	Disulphonic acid-S.

Trisulphonic Acids.	OH	SO_3H	SO_3H	SO_3H	
	1	2	4	7	Acid for Naphthol Yellow.
	1	3	6	8	Chromotrope acid.

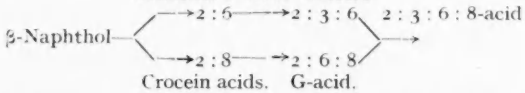
In the case of the sulphonic acids from the α-series it has been found that when the hydroxyl and sulphonic groups are in the 1 and 8 positions, there is the possibility of lactone formation between these two groups with the formation of a sultone (1). This fact considerably complicates the chemistry of the acids from this group.



(1)

The β-Acids

The sulphonic acids from β-naphthol are mainly prepared by the direct sulphonation of β-naphthol, the 2 : 6 and 2 : 8 acids being the first products, after which sulphonation proceeds according to the diagram below :—



The first step, therefore, in the preparation of the β-series of compounds is the monosulphonation of β-naphthol. This operation is conducted in a sulphonating kettle, fitted with the usual stirring and temperature regulating devices and made in a suitable resistant material such as heavily enamelled iron. The charge for a sulphonation of this character is β-naphthol (5 cwt.), sulphuric acid of 66. Be. (6 cwt.) and sulphuric acid monohydrate (1½ cwt.). The β-naphthol, which must have been carefully dried and ground to a very fine powder, is slowly sifted into the mixed acids, which have been allowed to mix at such a rate that the temperature has risen to 55° C. In some works the naphthol is added in three large portions, but the advisability and advantage of this is not evident. The temperature is raised to 97° C. by means of indirect steam, the steam being so regulated that the desired temperature is rapidly arrived at as soon as the addition of naphthol has ceased. After about an hour, the temperature is allowed to slack off to 90° C., and after 1¾ hours from the final addition of naphthol the whole batch is cooled off rapidly and run into water (500 gal.), any residual sulphur dioxide being blown off from the dilute liquid with steam (direct) at 100° C. It is usual to test the batch before running into water for the presence of free β-naphthol, which should be absent at this stage. A sample should yield a clear solution on dilution with water, and the aqueous solution so produced should yield nothing to either. The dilution is performed in a lead-lined vat of 800 gal. capacity, and when the residue of sulphur gases have been blown off as described, salt is added (18 cwt.). A precipitate forms immediately but only in small quantity, settling rapidly to the bottom of the vat from which the clear liquor is piped off and allowed to stand for two or three days, during which the sodium salt of Schaeffer's acid separates out. From time to time a sample is taken to the laboratory and tested by the addition of salt. If crystals form immediately, the separation is allowed to continue, but if the liquid remains clear, the separated crystals in the batch are filtered off at the press.

Analysis of Schaeffer Acid

The analysis of Schaeffer acid is usually undertaken to ascertain (*a*) the presence of free naphthol, (*b*) to estimate the amount of crocein acid present, (*c*) a direct determination of the Schaeffer acid present.

The free naphthol is readily estimated by shaking a 10 gm. sample with ether in a separating funnel and evaporating the ether extract in a tarred flask in the usual way. There should not be more than a trace of the free naphthol since it interferes with the colours produced when this intermediate is used as a component in azo-dye formation. The direct determination of the Schaeffer acid present depends on the fact that although the Schaeffer acid couples readily with diazotised aniline, the crocein acid combines much more slowly. In this way it is possible to titrate the one acid in the presence of the other, provided the titration is performed with reasonable speed. To carry out this test 21 gm. of the sample are weighed out into a three-litre beaker and dissolved in water. The solution is neutralised with sodium carbonate solution, made slightly alkaline, cooled in ice and titrated with standard diazotised aniline solution. The end of the titration is that point at which a drop of the filtered solution begins to give a colour with a filter paper moistened with diazo solution (presence of free diazobenzene salt) and the amount of Schaeffer acid can readily be calculated from the amount of diazo solution used in the titration.

It is more usual to test the solution of Schaeffer salt before use in the coupling. The yield by the process described amounts to 60–70 per cent. of the theoretical, much of the success of the operation depending on the care with which the heating is regulated during sulphonation. A too high temperature, or prolonged heating period, leads to the formation of a considerable amount of R-salt, of which there should only be the merest trace in the Schaeffer salt.

There are two uses of Schaeffer salt other than in the preparation of azo-dyes, namely, the formation of Naphthol Green, which is prepared by treating β-naphthol 2 : 6-sulphonic acid with nitrous acid when after prolonged stirring a nitroso compound is formed, this in turn giving Naphthol Green when treated with an iron salt. An intense eosin red can be prepared by treating Schaeffer acid with an excess of sodium nitrite and a moderate quantity of strong hydrochloric acid.

Dyestuffs Markets: The Month's Business in Review

From Our Own Correspondents

Lancashire

THE sudden and unexpected reduction in dyestuff prices made by I.C.I., Ltd., a year ago did not meet with the whole-hearted welcome that those responsible for the policy probably expected. Some of the largest users of dyestuffs felt that they might have been consulted before a change, in some respects so drastic, was made. It was also felt by some users, rightly or wrongly, that the new price policy was the beginning of a serious attempt on the part of I.C.I. to establish a monopoly of dyestuffs manufacture in this country. There were rumours that the policy was introduced following a failure to come to terms with the Swiss Group regarding the Clayton Aniline Co. Anyhow, the confidence of users in the North was still further shaken by the transference of the sales' headquarters to London.

Dyers and printers in Lancashire and Yorkshire have been accustomed in the past to intimate personal contact with the principals, whether English, German, or Swiss, of the dyestuff manufacturing concerns, and this centralisation in London appeared to be a move definitely in the opposite sense. The more recent changes that have taken place in the organisation of the Dyestuffs Group of I.C.I. are consequently agreeable to dye-users in the North. Apparently, the policy of decentralisation has been adopted to some extent, and the selling department is back again at Hexagon House.

The appointment of Dr. John Thomas and Mr. C. J. T. Cronshaw as joint general managers of the Dyestuffs Group is a reversion to a principle advocated in the early days of reconstruction; namely, that the principal executive positions should be filled by men of appropriate scientific and technical experience. The appointments of Mr. J. Baddiley and Mr. R. S. Horsfall, as joint technical managers, have necessitated other changes. Mr. M. Barrowcliff becomes head of the Research Department, and Mr. C. H. Barlow chief colourist. On the commercial side, Mr. D. R. Mackay is now manager.

There is a general feeling in the dyeing industries in the North that the unavoidable difficulties in organisation involved in the assimilation of the staffs of a number of works have now been overcome, and that the various dyestuff-making concerns of I.C.I., Ltd., are in a better position than at any time previously to meet the requirements of the users. There are signs that in future efforts will be made to maintain personal contact with important users and this, especially in view of the possibility of at least a much more open market for dyestuffs in the future, will be found of first-rate importance.

Scotland

The position in the tweed trade is still rather unsatisfactory. Orders from Europe and America have helped to keep things going, but all the same only a minority of the manufacturers have been able to keep their mills in full operation. At the moment, Botany worsteds and Cheviots are the busiest section.

Trade in chemicals during the month has been dull; dyestuffs have been fairly steady, with little change in prices. Dyeing and printing in the Glasgow district remain much as they were last month, and the level of employment is unaltered.

The damage caused by the recent fire at Scottish Dyes' works at Grangemouth is being rapidly repaired, and, so far as the exterior of the buildings is concerned, the reconstruction is now substantially complete.

Acceleration of Vulcanising

S. J. Peachey's Patent Extended

In the Chancery Division of the High Court on Wednesday, Mr. Justice Luxmoore had before him an application to extend the patent granted to Stanley John Peachey, of Platts Lane, Hampstead, for an accelerator for vulcanising.

Sir Duncan Kerly, K.C., for the applicant, explained that the normal vulcanising process, which was done under heat and pressure, took many hours, and he thought that Mr. Peachey was the first man to discover a really useful accelerator by means of which the process took minutes instead of hours. The invention was introduced in February, 1914, and by the time licences to work it were given to two chemists, the war broke out and the chemists were engaged in the manufacture of gas masks and T.N.T. Since then other chemists had discovered other alternatives before Mr. Peachey was able to reap the benefit of his invention. Up to the end of 1916 he had received £175 in royalties, up to the end of 1917 £649, and up to the end of 1918 £866. In 1922 the inventor received a capital sum of £2,000 from the British Dyestuffs Corporation. Since the war he had received on the average, about £1,300 a year.

Mr. Stafford Crossman, for the Comptroller of Patents, said he did not wish to reflect on the value of the patent, but in view of the progressive royalties received during the war years, the Comptroller suggested an extension for two years from February, 1930, when the patent expired.

His Lordship granted an extension of the patent for two years from the date of its expiry.

Growth of American Dyestuff Industry

"THE American dyestuff industry continues to make steady progress, and over 90 per cent. of the dye consumption of the country is produced here. In fact, there are too many dyes, as we have copied the prodigality of the Germans," stated Mr. Robert T. Baldwin in the course of a paper on "Recent Developments in American Chemical Industry," given before the Montreal Section of the Society of Chemical Industry. "The demand," he said, "for fast dyes, largely stimulated by the dye manufacturers themselves, is slowly altering the nature of the output as fast dyes obviously replace older types with less desirable properties. It is interesting to note that rags of fast dyed cottons in light shades are giving rag paper makers some difficulty in bleaching and require elaborate chemical treatments that threaten the cellulose itself. The erection of the American dyestuff industry was the first great change brought about in the chemical industry by the World War, and was the start of a real organic chemical industry. These fine new plants may be considered as great laboratories. Moreover, they are a constant element of national defence at no expense to the taxpayer."

Scientific Control in the Foundry

THE following note on "Scientific control in the foundry" is taken from the very useful handbook of practical information for the iron and steel industry and allied trades published by Beecroft and Partners, Ltd., of Sheffield, consulting metallurgists and foundry chemists:—

"During recent years the manufacture of both ferrous and non-ferrous products has approached and in some cases reached the state of an exact science. It is now possible by chemical, physical and miscroscopical control of the raw materials used, the intermediate operations, and the final product, to maintain a uniform standard result. Under present-day conditions, where economic considerations necessitate purchases being made in the cheapest markets, it is true to state that uniformity of product cannot be upheld without scientific control. The higher the grade of the product and the greater the difficulty of manufacture, the greater are the benefits to be derived from such methods of control as we have mentioned. Not only from a quality point of view is scientific control to be advocated, but also from monetary considerations. In fact, it is from its financial savings that it is to be chiefly recommended. Analytical and physical control of metallurgical operations reduces scrap. It saves fuel and refractories. It is no fanciful prophecy to say that the time will soon come when the manufacture of ferrous and non-ferrous materials will be economically unsuccessful, except in those plants which have the benefit of scientific control."

Dyestuffs Monthly Supplement

Published in the second issue of "The Chemical Age" each month

Communications relating to editorial matter for the Dyestuffs Monthly Supplement should be addressed to the Editor, THE CHEMICAL AGE, *Bouverie House, 154, Fleet Street, London, E.C.4. Advertisement matter, subscriptions, etc., should be sent to the Manager. The Supplement is devoted to the interests of both manufacturers and users of dyestuffs, and contributions will be welcomed.*

German Sales Propaganda

OUR readers' attention is particularly drawn to our Lancashire market correspondent's notes in this issue on the German sales campaign on behalf of fast colours. In view of the early termination of the period of ten years for which the Dyestuffs Act was passed, and the uncertainty of the future position, our correspondent's suggestions are of particular interest to British dyestuff manufacturers.

New B.D.C. Colours

Imperial Chemical Industries announce three additions to the British Dyestuffs Corporation range of colours, namely, Rhodamine BS, Chlorazol Fast Blue FFKS and Chlorazol Brown A.

Rhodamine BS is well known as one of the most valuable and widely used members of the basic colour class, being of interest in practically all branches of the textile dyeing industry for the production of brilliant bluish reds and pinks. It is of importance for textile printing, being suitable for topical printing in combination with tannic acid; for coloured discharges with Rongalite or tin crystals and also for resists under aniline black. In addition, the colour is largely used for the dyeing of paper and for lake making purposes. Its good solubility in spirit makes it suitable for all purposes where this property comes into consideration. It is also suitable for the colouring of soaps and for straw dyeing.

Chlorazol Brown A, an addition to the B.D.C. range of direct colours, is described as a level dyeing direct cotton dyestuff, which produces shades of a rich brown tone. It is suitable for the dyeing of all forms of cotton materials and should prove of particular interest to cotton piece dyers. It is also suitable for the dyeing of cotton and wool union materials, and should, therefore, be of interest to garment dyers. Chlorazol Brown A is dyed on cotton material in the manner usual for direct colours from a Glauber's salt or common salt bath.

Chlorazol Fast Blue FFKS, an addition to the B.D.C. range of direct cotton colours, belongs to the same class of fast-to-light direct cotton blues as Chlorazol Fast Blue 2BNS, and in comparison with the latter gives greener and brighter shades. It is particularly valuable on account of its excellent dyeing properties. It possesses very good level dyeing power and is suitable for the dyeing of piece goods, mercerised yarns and fancy woven articles. Owing to its good solubility and levelling power it is recommended for machine dyeing. It is applicable to wool-cotton union materials where it is required to dye the cotton in a cold or lukewarm bath and leave the wool unstained.

American Spring and Summer Colours

According to an annoucement made by Margaret Hayden Rorke, managing director, the American Textile Colour Card Association has just issued its colour correlation chart for the 1930 spring and summer seasons.

Included in the list are the shades which leading apparel industries have chosen for spring and summer promotion. The outstanding colour families for daytime and evening wear are divided in groups according to their cast, and for each group are suggested the fashionable shades in shoes, hosiery and other accessories.

Blues, for example, are classified in darker tones, such as greyed blues, violet blues, purplish blues and navies, while the lighter blues for sports and resort wear include sky and baby blue types, aquamarine and turquoise. A special feature of the chart is a collection of fashionable bi-colour themes adaptable to town, sports and beach wear. The darker ground colours, such as blue, green, brown and black, are subdivided as to cast, and for each important colour class lighter tones which smartly blend or contrast are suggested. For example, Kyoto Blue is allied with Linen Blue, Viking Brown with Beige Clair, and Black with Cloud Pink. From the merchandising angle, the chart is designed to assist the retailer in carrying out an effective colour correlation plan in the apparel and costume accessory departments of stores.

Arsenic in Food Colours

The sub-committee appointed by the Standing Committee on the Uniformity of Analytical Methods, of the Society of Public Analysts, "to investigate, formulate, and recommend, methods for the determination of poisonous metals in food colouring materials," has now issued its first report, which deals with the determination of arsenic. The method recommended is the destructive wet oxidation of the colouring matter, utilising nitric acid for the purpose. The arsenic may be estimated in the oxidation mix, but for more accurate results the sub-committee recommend the freeing of the arsenic from disturbing substances by means of a preliminary distillation. A modified Gutzeit method is employed for the actual arsenic estimation. Copies of the report, the cost of which is 6d., can be obtained from *The Analyst*, 85, Eccleston Square, London, S.W.1.

Bradford Dyers

Mr. George Douglas (chairman), speaking at the annual meeting of the Bradford Dyers Association last week, referred to the decline in the exports of cotton piece goods in 1929, and said that while each group—grey, bleached, printed, and dyed—had shown a continued falling off, the decrease in the dyed group was smaller than that in the others. Certain piece-dyed fabrics of a speciality character—mainly of Egyptian yarn—had not yet been directly affected by the competition of foreign producers, who could not equal Lancashire either in the finer yarns or in the weaving of higher-grade cloths. The skill of the British dyer had had full play on these finer cloths, and it was these that the piece-dyed trade had been best able to retain. It was menaced, however, by the world manufacture of artificial silk fabrics. The Association's trade in artificial silk fabrics had progressed very favourably, and its work on the crêpe-de-Chine and allied types was widely known and appreciated. A large part of the set-back in artificial silk goods exports, it was to be feared, was attributable to uncertainty concerning silk duties.

Official Colours for U.S.A. Army

The colours authorised for wear on the blue uniform by the United States Army have been standardised, and are shown in the United States Army Colour Card just

issued by the Textile Colour Card Association of the United States. This card contains eighteen colours and has been approved and accepted by the Quartermaster-General:

In addition to white and black there are two shades of yellow, two of orange, one scarlet, one crimson, one green, one purple, one grey, one maroon, four blues, one buff and one brown. On the card is printed the official list of the twenty-four Arms and Services of the Army, and there is designated the colour or combination of colours assigned to each.

The card will be supplied to each post, camp, and station in the Army, numbering about 300. The purchasing depots will use the card as the standard for shade whenever any textile articles are required, such as facing cloths, for stripes, chevrons, cape linings, shoulder insignia, etc., cord edge, braids for dress coats and cap band ribbons for dress caps, to indicate or identify the Arms and Services. The principal use for these colour cards will be in the purchase of dress uniforms by officers and enlisted men, as these cards will govern the colours of the trimmings on all uniforms.

A few of these colours have been used by the Army for decorative purposes on uniforms since the Revolutionary War. At the outbreak of the European War the wearing of the blue uniform was suspended, and it is only recently that its use has again been permitted. Naturally, its reauthorisation carried with it all the original colours worn by the various organisations, plus those incorporated during and immediately after the European War.

Fastness of Dyes to Perspiration

Professor McSwiney's Review of Recent Research

A meeting of the Manchester Section of the Society of Dyers and Colourists was held on Friday, February 21, when Professor B. A. McSwiney read a paper on "The Problem of the Fastness of Dyes to Perspiration." Mr. G. E. Holden presided.

PROFESSOR MCSWINEY said that the work referred to in the paper had been conducted, in collaboration with Dr. C. C. N. Vass, at the Leeds University School of Medicine on behalf of the Society, and the results described were really in the nature of an interim report. A final stage had not yet been reached. If the perspiration and fatty exudations from the cheek were taken to be of the value of 100, then those from the palm of the hand could be regarded as 90, and those of the axilla, or hollow between the arm and the chest, as 45. Therefore, from these uneven secretions of the different parts of the body it followed that no quantities could be calculated accurately by a quantity secreted by a small part of the skin in any given time as contrasted with the whole body.

In normal temperature and in normal climates the major portion of the water taken into the body was secreted by the kidneys and a smaller portion by the lungs and the surface of the skin, the secretion of water by the skin being mainly determined by the need for regulating the temperature of the body. The water evaporated from the surface of the body was termed "insensible" perspiration, and was due to the evaporation of the water from the surface of the cuticle itself, altogether apart from the sweat glands, the sweat formed by the glands being the most dilute of all animal fluids. After filtration it formed a clear colourless fluid with a specific gravity of 1·003, water being in the proportion of 99 per cent. and its most solid constituent being sodium chloride, the amount of which was variously stated as being from ·3 to ·5 per cent. It was also stated to contain small quantities of protein and urea.

Regulation of Body Temperature

In the regions of the axillæ and the groins there was a somewhat penetrating odour due to the presence of fatty acids. The secretion of sweat was under the control of the central nervous system, and was almost entirely adapted to the regulation of the body temperature. The nervous mechanism could be set into activity either centrally by the discharge of nerve impulses from the brain or in a reflex manner due to the stimulation of some particular part of the body, and it usually began when the temperature of the body attained a height of ·5 to 1° C. above normal. In ordinary circumstances stimulus by warm blood was the predominant factor. It was, in fact, the method used by the body in order to regain a normal temperature.

There was a remarkable divergence in the published literature with regard to the characters of the constituents of sweat. Many investigators stated that perspiration was alkaline, but in 1919 Talbot showed that it was definitely acid, and that bodily sweat could only be made alkaline with difficulty as the result of incubating at 37° C. for a number of hours, the result, as he claimed, being due to bacterial decomposition. The variations noticed by previous observers were probably due to the methods of collecting the samples, the amounts of sweat collected, the intervals elapsing between the collection and the analysis, and the manner in which the samples were kept. The present investigation was undertaken with the endeavour to obtain the variations in the constituents of sweat as it was collected from the body, and to establish minimum, average, and maximum data by making investigations with regard to a large number of individuals, and also to ascertain if people who were suffering from differing conditions of health showed any difference in the composition of the sweat which they secreted.

A Series of Experiments

For the purpose of ascertaining the fastness of dyestuffs to bodily exudations, not only those from the sweat glands, but also those from sebaceous glands, had been considered. During the course of the experiments every possible precaution was taken to ensure that the sweat collected was not contaminated by any outside source, and when obtained it was found to be a turbid colourless fluid containing varying amounts of epithelial debris. As soon as possible, a measurement was made of the hydrogen ion concentration and the ammonia-nitrogen. A slide was exhibited on the screen showing the quantity of sweat collected from 16 normal men. The smallest amount collected was 10 c.c., while the maximum obtained from any individual was 350 c.c. The minimum hydrogen ion concentration was 5·1 and the maximum 7·3; the ammonia-nitrogen, in milligrammes per 100 c.c., was 3·12 minimum and 7·0 maximum; the urea-nitrogen, in terms of milligrammes per 100 c.c., minimum 11 and maximum 33·5; glucose 7·26 minimum and 26·4 maximum; chlorides, minimum 2·34, maximum 5·01; amino-acid-nitrogen, in milligrammes per 100 c.c., from 7·3 minimum to 9·8 maximum. A noticeable feature was the great amount of glucose secreted in the sweat of women as contrasted with that of men, particularly in the case of stout women, there being practically a difference of 100 per cent. between a normal woman and a stout woman. What this implied physiologically was not yet known. As regards dyestuffs, it might possibly have a reducing action. The women were perfectly normal, and the blood sugar was perfectly normal. The sweat of an individual suffering from rheumatism showed distinctly alkaline characteristics.

If, at the end of 147 hours, sweat was inoculated with *Staphylococcus albus*, the ordinary bacterium present in the skin, the ammonia content immediately rose in quantity, the bacteria using the urea for the purpose.

Dr. McSwiney stated that a stage had now been reached in the investigations when it was possible to give figures for the minimum and maximum concentrations of shed sweat, and that at the present time they were continuing their research work in regard to the constitution of sweat from dark-skinned people. It was hoped that in the future they would be able to make some tentative suggestions as to the character of test which should be used to determine the fastness of dyed fabrics to perspiration.

Diagnosis of Colour Faults in Finished Goods

By F. L. Goodall

At a joint meeting of the London Section of the Textile Institute and the Society of Dyers and Colourists, held on February 21, at the Chemical Society's Rooms, Burlington House, London, Mr. F. L. Goodall, of the Geigy Colour Co., Bradford, gave a most interesting lecture on "The Diagnosis of Colour Faults in Finished Goods." The chair was taken by Mr. F. W. Walker (Eastman and Sons, Ltd).

In the course of his address, Mr. Goodall said that he did not wish to talk about faults in actual dyeing processes—for even dyers sometimes had accidents—but rather to discuss faults which arose before and after dyeing, and for which a dyer was frequently, though wrongly, held responsible. His remarks would deal mainly with wool, but some of them had other applications as well. Wool and cotton were dyed in almost any form—in the loose state, in the sliver, the yarn or the piece. At every dyeing point, it had almost always had some chemical treatment prior to dyeing, and, again, in almost every case it had to stand chemical and physical treatment after dyeing—such processes, for instance, as the scouring of loose material, the oiling of tops or blends, the oiling of yarns in spinning, the conditioning of yarns, the scouring and setting of yarns, and the scouring, crabbing and milling of pieces.

These processes were all essential in the preparation of practically all woollen fabrics. In certain other cases there were the comparatively drastic chemical treatments involved in sulphur stoving, peroxide bleaching, carbonising and chlorination. Then, in addition, the material was expected to remain unaffected when stored in the hands of manufacturer, merchant, retailer, or the ultimate consumer, and in the hands of the latter it must fulfil domestic requirements of fastness.

Investigating Colour Faults

There were innumerable conditions under which a colour might fail and the first thing to do in tackling any fault, when the colour itself was obviously not to blame, was to get as many particulars as possible with regard to it, for the slightest detail might be valuable in determining the cause. The next thing was to consider all the varying treatments which the goods had had, and next to make experiments on small samples with the object of reproducing the fault, for, if by certain methods a fault could be reproduced, it was almost certain that the original fault was cased by the same or similar methods.

Even though cases of colour failure were almost always brought about by treatment involving chemical action, investigators were not always aware that any particular treatment involved chemical treatment at all, *e.g.*, it was not generally known that many tailors, when pressing clothes, soaped the garment. All normal processes in wool involved the use of alkali and the generally practised method of removing this alkali was by washing the goods in water, but it could not be completely removed except by prolonged washing, so that all woollen goods were slightly alkaline unless special precautions had been taken to neutralise any residual alkalinity by the addition of formic or acetic acids or ammonium salts to the washing-off water after scouring and milling, unless the last manufacturing process was the dyeing, in which case the goods would be slightly acid as a result of being dyed from an acid dyebath. Practically all piece-dyed goods were, therefore, slightly acid, while slubbing or loose wool dyed piece goods, such as all patterned goods, were slightly alkaline.

Effects of Alkali

Wool containing alkali would, if dyed while still wet, dye a much fuller shade than wool free from alkali. The importance of complete removal of alkali throughout a batch of goods and its effect on level dyeing was obvious. If an individual piece was not thoroughly washed off and still contained alkali, no great harm was done, provided the alkali was evenly distributed, and the goods were either dried or dyed immediately, but if they were left lying about in a wet state, the exposed edges slightly dried, and the liquor crept from the unexposed part to the exposed part, carrying soda with it, until finally there was a high concentration on the centre of the batch where there had been no exposure. Obviously such goods would dye unevenly and in many cases the exposed portions would dye darker than the rest, but sometimes owing to the attacks of bacteria they dyed lighter.

It was, of course, possible to make even fast chrome colours stain by scouring with alkali at too high a temperature, but in the dyeing process the goods were subjected to a higher temperature than in any scouring machine, and if alkali was not completely removed before drying—although the amount left might be very small—the concentration of the alkali solution in the goods became higher as drying proceeded, and the combined effect of the high temperature in the dryer and the strong alkali solution then in the cloth would cause the goods to be stained and off shade.

Another danger was that all goods were steam blown and if the cloth contained alkali it was very probable that there would be stained or off-shade pieces. Thus residual alkali left in goods might lead to unevenness in subsequent dyeing, by its own action, and in the case of goods already dyed might cause staining and alteration of shade. It was also responsible in most goods for promoting the development of bacteriological action and the development of one form of mildew and also for the development of sulphite faults.

The Dyer Blamed for Scourer's Faults

In every case the dyer was blamed for faulty dyeing and faulty dyestuffs, and in about every case the scourer was to blame. The use of ammonium sulphate as a remover of alkali had been recommended but for obvious reasons it was not so efficient as adding a volatile acid which evaporated off on drying the goods. Incomplete removal of alkali was the commonest cause of apparently inexplicable colour failure from the manufacturing point of view. Exactly similar faults were caused by it in the ordinary domestic laundering. No doubt many of them had heard complaints about streakiness after washing woollen jumpers. If it was realised that, when rinsing woollen goods, plenty of warm water was required, and the garments were dipped in weak acetic acid before finally drying, they could be dried in very hot places without any fear of the colour running.

Sulphite Faults

Turning to sulphite faults, Mr. Goodall said that these were closely related to, and often dependent on, a previous residual alkali fault. His firm had devised a simple test which took the form of spotting the test pattern with four solutions containing different relative proportions of SO_2 and alkali, and leaving the spots to dry for 12 hours. They would remember that he had emphasised the fact that nearly all woollen goods, except those which went straight from the dyehouse into finished articles, were slightly alkaline. It followed that in an atmosphere containing SO_2 even in small quantities, the alkaline goods would gradually absorb SO_2 from the surrounding atmosphere, and eventually the relative proportions of the alkali and SO_2 would reach the stage at which azo-sulphite formation proceeded, and a fault was produced, and there was a change of shade wherever the goods had been in contact with the air. This happened with every class of dyed fibre.

There were other carriers of SO_2 or sulphite apart from the atmosphere, which might give rise to similar faults. In the case of a two-fold yarn, in which one twist was stoved, the SO_2 contained in the stoved twist might completely alter the shade of the coloured twist in contact with it, or of an adjacent bundle of yarn during storage. Then there was the case of sulphite formed by oxidation of residual sulphur and sodium sulphide left in dyeings made with sulphur colours, leaving cuttle bars at intervals across the piece, wherever the cloth had been exposed to air while in storage.

Faults in Packing Paper

By far the commonest cause of sulphite faults lay in the packing paper used in packing goods in warehouses, shops, etc. Wood pulp was generally freed from lignin by extraction with calcium bisulphite solution, and when such pulp was made into paper, some sulphite was always retained by the paper. Linen and cotton rags, etc., used for making fresh paper were

bleached with bleaching powder, and hypochlorite and sulphites were added as antichlors.

This presence of sulphur in paper did great damage to dyed goods if left parcelled up for any length of time. In order to test thoroughly the fastness of a dyed pattern to SO_2 under all conditions, it was necessary not only to make the ordinary stoving test and his own firm's sulphite test, but also a further more drastic test involving the use of either the sulphite solutions hot, or a hydrosulphite solution. Hydrosulphite could and would reduce other classes of colours besides azo-colours, and it might reasonably be inferred that active sulphite would have a similar action.

Only such colours as were exceptionally resistant to reducing agents were quite unaffected by active sulphite. The fastest were those which were not, or were hardly, reducible with hydrosulphite—Eirochrome Red B, Anthracene Browns, Alizarine Cyanines, etc., and the next fast were those colours which although reduced by hydrosulphite were re-oxidised by air alone, such as brilliant wool blues, Eric Fast Fuschine BL, Rhodamine B, vat and sulphur colours. He had personally come into contact with active sulphite effects not only on azo-colours but also on triphenyl methane colours such as Patent Blue, acid anthraquinone colours, and also in vat colours.

All the faults he had mentioned due to SO_2 could arise, and often did, during storage in the dark. Exposure to light in general had nothing to do with the fault. He mentioned that the azo-sulphites, when formed, were not so fast to light as the parent dyestuffs. Even if only a small proportion of the dyestuff on any pattern was converted to azo-sulphite, the pattern would fade quicker than it should do.

Mr. Goodall, who illustrated the points he made by samples of various cloths, yarn, etc., was accorded a hearty vote of thanks.

Dyes and Their Application: Recent Technical Progress

By L. J. Hooley

Cellulose Acetate

In the last two or three years' research on the dyeing of cellulose acetate, emphasis has been laid on the methods of dyeing rather than on general dye synthesis, and special problems such as discharging, mordanting and the production of blacks have been occupying attention. A brief summary of some of the more important of these is given below.

Mordanting and Weighting

To overcome the resistance of cellulose acetate to the usual mordanting agents, the use of a very strong solution, for example 40 to 55 per cent. of a ferric salt, or similar concentration of an aluminium or chrome mordant, has been recommended; zinc salts can be included in the mordanting liquor. The mordant metal may also be applied as the salt of a hydroxy aliphatic acid (B.P. 273,692–3, 280,698, 286,761, 287,204, 309,899, Brit. Celanese, Ltd.), or the process can be carried out in the presence of a swelling agent, such as furfuraldehyde or an organic acid, or alternatively, a thiocyanate can be used as a mordant with the addition of excess thiocyanate to serve as a swelling agent. When mordanted the acetyl silk can be dyed with alizarine or similar colours.

In B.P. 309,148 (I.G.F.A.-G.) complex metal salts of mordant dyestuffs are applied to the unmordanted material; this method is of more interest in connection with the production of varnishes, waxes and similar substances made from cellulose esters or ethers.

Cellulose acetate can be loaded with the same salts as natural silk, and can then be dyed with similar dyes (B.P. 270,987, R. Clavel). In B.P. 279,502 (Brit. Celanese, Ltd.), tin salt solutions of such concentration as will also act as gelling agents are used and in B.P. 302,775 (Ibid.) a swelling agent is used with an alkaline tin salt. A pre-treatment with a basic metallic acetate, *e.g.*, basic aluminium acetate and an organic acid, is stated to give sharper outlines in printing acetyl silk.

Delustreing and Relustreing

As in the case of the other artificial silks, the lustre of cellulose acetate is sometimes an advantage and sometimes the contrary. Owing to the sensitivity of the material, the lustre is easily destroyed or damaged, while in some cases the material is also liable to take on too high a lustre. Attention has, therefore, been directed both to modifying the lustre and to restoring it after destruction, while deliberate use of these possibilities of variation has also been made for producing pattern effects. Delustreing can be carried out with perfect regularity and without spoiling the appearance or strength by soaking cold for several hours in a solution of calcium, lithium or magnesium chloride of 10 to 30 per cent. strength, squeezing and giving a short boil in very dilute acid (B.P. 301,335, Soc. Farb. Soie "Rhodiaseta").

Alternative methods of delustreing are padding with a soap solution and steaming, or treating with acids.

For the recovery of lustre, ethyl lactate or ethylene glycol are satisfactory (B.P. 301,567, 311,306, 303,286, Bleachers' Assoc., Ltd.). If the whole material be first delustred and then printed with a thickened paste containing the ethyl lactate, dried and then washed, the printed parts come up with a higher lustre; dyes may also be added to the printing paste.

A fabric with its normal lustre may also be printed with a paste containing a delustreing or relustreing agent (B.P. 306,534 Brit. Celanese, Ltd.).

The increase of lustre which is liable to take place on ironing acetyl silk damp when at high temperature can be avoided by impregnation at 40° with a 1 to 5 per cent. solution of basic aluminium acetate (B.P. 299,058, ibid.).

Miscellaneous Dyeing Methods

Treatment with potassium permanganate followed by sodium bisulphite is recommended for clearing whites after printing (B.P. 270,657 Etabl. Petitdidier).

In using azo colours the goods are padded with a mixture of the amine and other constituent along with a nitrite which is stated to assist absorption, after padding an acid treatment is given (B.P. 287,651 I.G.F.A.-G.). In B.P. 297,374 (idem.) the amine and other constituent are printed along with an organic solvent, the nitrite being added either to the printing paste or to the acid. Staining of cellulose acetate when dyeing in the presence of other fibres is avoided or diminished by using condensation products of phenols and formaldehyde (B.P. 306,876, idem.). Dyeing is carried out by means of transfers after moistening with a softener (B.P. 293,022, Brit. Celanese, Ltd.).

Dyeing from Organic Liquids

Organic solvents can sometimes be used instead of water for colouring cellulose acetate and similar organic derivatives of cellulose, as the silk does not offer the same resistance to these as to water. Alcohols, and their ethers or esters, benzene, and ethylene dichloride are among the solvents which have been mentioned, while the amino-anthraquinones have been instanced as suitable for use in this way. The method is convenient for spraying dyeing, especially to obtain good penetration and for other special purposes; it is obviously unsuitable for general use. (B.P. 282,036, 308,173, 313,450, 313,451, 314,208, Brit. Celanese, Ltd.).

Swelling and Hydrolysis

The hydrolysis of cellulose acetate as a means of dyeing has, of course, lost its general interest, but some new variations of methods of hydrolysis, including the use of zincates and gaseous saponifying agents, for example, ammonia, have been given. Methods of hydrolysis have also been extended to the other cellulose esters and ethers as well as nitro-cellulose. (B.P. 306,611, 313,971, 316,521).

A swelling treatment has been combined with the use of a solubilised dyestuff (B.P. 285,942, ibid.).

Discharging

Discharging has always been a difficulty, partly because the discharging agents are normally inorganic compounds which do not penetrate readily and partly because the treatment may not be too drastic.

To overcome the penetration difficulty a phenolic body, particularly resorcinol, may be added with the hydrosulphite (Scheurer, Lauth & Cie. *Bull. Soc. Ind.*, Mulhouse, 1929,

95, 349-352), or a swelling agent may be used (B.P. 260,289, Brit. Celanese, Ltd.).

Among the oxidation discharges chlorates, with or without accelerators, catalysts or assistants may be used. In some cases the discharge is only a partial one, thus 1 : 4-diaminoanthraquinone is discharged to a yellow (B.P. 312,655, 315,005 idem). A novel method is the use of charcoal, which acts as an adsorber. A perfectly white discharge is stated to be obtained with Duranol Red G by printing with animal charcoal and gum tragacanth and steaming for one hour at 95° C. (B.P. 297,186, Soc. Farb. Soie "Rhodiaseta"). Use can be made of the old method of hydrolysis by discharging the wholly or partially saponified acetate which has been dyed with dischargeable dyestuffs (B.P. 317,333, I.G.F.A.-G.).

White or coloured discharged effects can be obtained by producing a dischargeable azo dye on the fibre, topping this with a direct colour and then treating with a suitable discharge paste. A somewhat similar method of obtaining white discharges on black and navy blue grounds is described by D. R. Fisher (*Melliand's Textilb.*, 1929, **10**, 47). Black dyeings with white resists are obtained in B.P. 311,467 (I.G.F.A.-G.).

Pattern and Other Effects

The unique properties of cellulose acetate, especially the unique dyeing properties, make it especially suitable for use in obtaining pattern and other effects. If yarn in cop, bobbin or similar form is immersed in a dye bath and the dye only allowed to partially penetrate, the yarn on unwinding shows variations in depth from point to point, or it may be dyed in some parts and colourless in others; still more varied effects may be obtained by the use of two or more dyestuffs. According to the type of winding adopted different effects are obtained on weaving. As examples, with a bottle type of winding and a knitted weave, a speckled effect is obtained; with the parallel-wind bobbin and a weft-faced satin, light and dark bands appear. This device can, of course, be used with other materials (B.P. 269,195, Brit. Celanese, Ltd.). The cellulose acetate material may be locally saponified and then dyed with a special dyestuff, for example, a Duranol which only dyes the unsaponified portions (B.P. 310,844, Lyons Piece Dye Works).

In dyeing with colours requiring oxidation, for example, of the aniline black type, the material may be locally printed with an alkali and reducing agent to inhibit oxidation (B.P. 314,501, Brit. Celanese, Ltd.). Photographic designs or illustrations can be obtained by dyeing with an azo component, exposing to light, and then developing.

The methods just mentioned are suitable for acetyl silk alone: among methods suitable for mixed fibres those of B.P. 316,982 and 317,452 (Brit. Celanese, Ltd.) may be mentioned. In the former a material with a cellulose acetate warp and a different weft is locally printed with suitable dyestuffs. In the latter, ordinary cellulose acetate is used in the warp and a treated cellulose acetate in the weft and the material then dyed or printed.

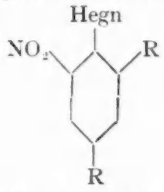
Blacks

A variety of blacks which may be regarded as of the aniline black type have been recommended for acetyl silk. In B.P. 298,699 (Brit. Celanese, Ltd.) the essential feature is the use of a chlor-amide as the oxidising agent for the amine. In an example, *p*-aminodiphenylamine is pasted with Turkey Red oil and dyed on to the material at 40-80°, then, after washing, exhaustion is carried out in a 0·4 per cent. solution of *p*-toluenesulphon chlor amide sodium salt at 75°, with a little acetic acid for a quarter of an hour. In B.P. 311,435 a mixture of *p*-aminodiphenylamine and aniline is used as the amine. Fat or wax resists may be printed on the material before impregnating with the aminodiphenylamine (B.P. 311,467(.

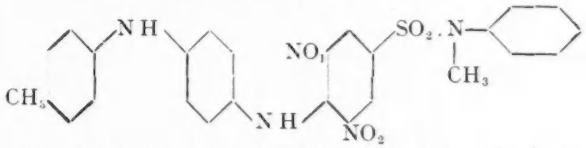
A modification of the process for producing black dyeings on acetyl silk by the oxidation of diamino-diphenylamine consists in using 2 : 4-dinitrodiphenylamine in the dye liquor and reducing it to the diamine at or about the same time as or subsequent to its application to the cellulose acetate and then giving it an oxidising treatment. (B.P. 322,893, Silver Springs Bleach. and Dye. Co.).

Nitro Dyes

There has been a slight revival in the interest taken in nitro dyes as the result of the suitability of some of them for acetyl silk. In B.P. 279,133 yellow to reddish-brown dyes are obtained by condensing *p*-aminodiphenylamine or one of its substitution products with a nitro derivative of the formula shown, where one of the R groups is also a nitro and the other belongs to certain types of acid or substituted acid groups.



In an example 4-amino-4¹-methyldiphenylamine-2-sulphonic acid is condensed to give a compound.



Somewhat similar products are described in the two following patents: 279,134-5.

The acetoacetyl derivative of 2 : 4-dinitro-4¹-aminodiphenylamine is described in B.P. 299,349 (Brit. Celanese, Ltd.). This gives a greenish yellow. Other nitrodiphenylamine derivatives are given in B.P. 305,560 (Brit. Celanese, Ltd.).

Woollen and Worsted Research

The Fading of Dyed Goods

THE annual report of the Council of the British Research Association for the Woollen and Worsted Industries states that the work of the colour department during 1929 has been of two complementary types, namely, fundamental research, to find out what factors are responsible for the fading of dyed goods, and outdoor tests, to see how the goods behave under practical conditions.

During the summer of 1929 representative ranges of dyestuffs on wool, silk, cotton and viscose, were exposed at Torridon, Clifford (Wetherby), and Falmouth, while a further set is at present being exposed at Kodaikanal in India.

Although there is more fading with some dyes in Leeds than in certain foreign dry places, nevertheless there is a considerable number of dyes which fade to approximately the same extent in different parts of the world, provided exposures are made to strong sun only, during the six middle hours of the day.

Work has continued on establishing an improved standard fading lamp both by testing different light sources and by control of humidity. During the course of this work it has been realised that temperature is a factor which can by no means be neglected, and apparatus has been devised to carry out tests at different temperatures and different humidities simultaneously.

Measurement of Colour

Some advance has been made in the interpretation of the results of the measurement of colour, using the Guild colorimeter, the spectrophotometer, and the Lovibond Tintometer, and a series of papers has been published. It has been shown that the Guild colorimeter lends itself to expressing change of colour on a graph, which gives a fair picture of the changes. Moreover, if the dyestuff fades without change of hue, the fading can be expressed as an actual loss of surface dyestuff, and in this way it has been shown that the percentage loss of dyestuff is the same for a given exposure no matter what may be the original concentration of dyestuff. It must not be inferred from this that the visual fading is the same; indeed it follows from measurements that a pale shade appears to lose colour more rapidly than does a deep shade. In conjunction with Mr. F. W. Twyman, F.R.S., of Adam Hilger, Ltd., London, a method of expressing fading by a single number has been actively worked upon, using the Guild colorimeter. The scheme is well advanced, and a table for practical use is now being drawn up and will be published shortly. Incidentally it is recorded that Mr. F. W. Twyman has generously paid the salary of one of the assistants engaged in this work for a period of six months.

Dyestuffs Markets: The Month's Business in Review

From Our Own Correspondents

Lancashire

IT is generally known that the measure of protection which has been afforded to the dye-making industry may come to an end this year. The Chancellor of the Exchequer has made his general attitude on the matter of protection quite clear, but, apart from this, there appears to be a complete absence of any informed opinion in the dyeing trade about the course the Government will take. In the event of the establishment of a free market for dyestuffs in this country it is certain that a powerful attack will be made by the I.G., and it is probable that the more expensive dyestuffs, mainly the vat colours and Napthol AS range, in the cases of cotton, will be the main object of their campaign.

It is, therefore, important to take note of the very large measure of success which has attended the efforts of the I.G. to popularise in Germany and elsewhere the Indanthren range of dyestuffs. The propaganda of the I.G. has succeeded to a very considerable extent in making the word "Indanthren" synonymous with "fastest possible." Not only in Germany but in other continental countries retailers and housewives refer quite familiarly to "Indanthren," and mean by the term "something which stands very severe washing and exposure to light."

It is not only on the Continent that they have imposed the word on the ultimate user of fast dyed fabrics, but even in Indian and other eastern countries they have been so successful that English dyers in recent times have been asked to guarantee that their cloths are "Indanthren-dyed." The special Indanthren ticket is apparently supplied by the I.G. to those who use the Indanthren colours, and in this connection it must be remembered that Indanthren here includes not only selected anthraquinonoid vat dyes, but also selected azoic combinations possessing high degress of fastness to light, washing, and so on.

The propaganda has been carried on in a very thorough manner. Visitors to Germany are familiar with the Indanthren shops which exist in nearly all the large towns, and in which are sold nearly every class of textiles, dyed or printed with the Indanthren colours. These shops have the specific purpose of familiarising the public with the name and the properties of the dyes and dyeings.

The situation in this country is complicated to some extent by the fact that although Imperial Chemical Industries, Ltd., are by far the largest manufacturers of vat dyes, the British Alizarine Co., Ltd., Messrs. L. B. Holliday, and perhaps one other dye manufacturer, are producing vat dyes of the Indanthren type, and it is further to be remembered that many dye users, including some of the largest, have their own branded lines, often of guaranteed fastness to light, and they may be opposed to the establishment in this country of anything corresponding to the German Indanthren ticket. However, pressure from overseas buyers may compel the dyer in this country either to use Indanthren dyes to the exclusion of British-made anthraquinonoid vat colours, or, alternatively, to establish a quality ticket attachable only to goods coloured in the fastest possible fashion.

Scotland

Conditions during January have been very disappointing. Trade had not been too good since the opening of the year and a further slight setback was noticed at the beginning of February, and, if anything, has become more noticeable since. For example, the position was rather brighter at Thornliebank than in other districts round Glasgow, and now even here the conditions are not so good. It does not appear to be the dyeing trade alone, however, that is experiencing these conditions.

In the tweed trade there was a slight improvement towards the middle of the month, but this has not been maintained. Orders for the next winter season are only coming in slowly and the fall in the price of wool has made buyers cautious. At the same time a fall in export trade, especially with the United States, is reported.

Wheatland's Mill, Galashiels, formerly belonging to Arthur Dickson and Co., Ltd., has been taken over by Munro and Co., Ltd., Edinburgh, for the manufacture of knitted and other woollen goods.

Alizarine Dyestuffs in Lake Condition upon Cotton

Colorimetric Determination

LIEBERMANN'S gravimetric method of determination of the alizarine (and similar dyestuffs) present in dyed materials is a roundabout one, and attended with certain difficulties. The authors* have worked out a colorimetric method which can be followed out and completed in a short time, without difficulty, and with small swatches, while the Liebermann method requires as much as 1 or 2 square meters of the goods to be tested. This colorimetric method depends upon the destruction of the fabric and of the colour lake by treatment at ordinary temperature with 70 per cent. sulphuric acid, the addition of caustic alkali to neutralise the acid and to dissolve the dyestuffs to the characteristic blue-violet colour, and the comparison of this solution, in the colorimeter, with a standard solution. The authors state that they "have left nothing unregarded; the influence of an excess of caustic upon the intensity of the blue-violet colour, which Liebermann noticed, and which has, even up to the present, received no satisfactory explanation; and the question as to how far the cellulose in the alkaline solution has any bearing upon the colour, for which reason we have in several cases used standard solutions with cellulose added."

In four experiments, which are given in detail, the results checked within 2·1 and 2·2 per cent. 0·7 and 1·1 per cent., 1·1 and 0·4 per cent., and 1·0 and 1·6 per cent., which for technical analyses on such materials and for such purposes is a fairly good check; at all events, sufficiently good for all ordinary purposes. These results were obtained with pure alizarine as a preliminary testing-out of the accuracy obtainable. It was found, on extending the method to dyed material, that the solution prepared from the dyed fabric to be tested became lighter on standing for some time before examination in the colorimeter. The authors suggest tentatively that this may be due to the formation of sugars from the action of the acid upon the cellulose in the destruction of the fibre, and that these sugars, if given time, may reduce some of the alizarine to the leuco condition. They only suggest this, but the suggestion appears to be reasonable. The colorimetric determination has therefore to be made, not necessarily immediately but without delay. A table is given showing the drop in apparent percentage of alizarine through keeping the standard (containing cellulose disintegrated by sulphuric acid); the value ranges from 100 per cent. on immediate examination, through 99·7 per cent. after two hours' standing (and the same figure after twenty-four hours), and 95·2 per cent. after five hours', to 81·5 per cent. after forty-eight hours'.

Like all colorimetric methods, a certain amount of experience is necessary before good checks can be obtained. When a mixture of alizarine dyestuffs has been used, of course the same mixture must be employed for establishing the standard.

*W. Minajeff and K. Swietliakow; *Mell. Textil-Ber.* **10**, 796 (1929).

Dyestuffs Licences for February

THE following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during February has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee:—

The total number of applications received during the month was 746, of which 637 were from merchants or importers. To these should be added 18 cases outstanding on January 31, 1930, making a total for the month of 764. These were dealt with as follows: Granted, 706 (of which 683 were dealt with within seven days of receipt); referred to British makers of similar products, 34 (of which 26 were dealt with within seven days of receipt); outstanding on February 28, 24. Of the total of 764 applications received, 709, or 93 per cent., were dealt with within seven days of receipt.

Dyestuffs Monthly Supplement

Published in the second issue of "The Chemical Age" each month

Communications relating to editorial matter for the Dyestuffs Monthly Supplement should be addressed to the Editor, THE CHEMICAL AGE, Bouverie House, 154, Fleet Street, London, E.C.4. Advertisement matter, subscriptions, etc., should be sent to the Manager. The Supplement is devoted to the interests of both manufacturers and users of dyestuffs, and contributions will be welcomed.

Interest in the Dyestuffs Action

KEEN interest was aroused in the North of England, writes our Lancashire correspondent, in the progress and result of the important patent action, concerned principally with colours of the Naphthol AS class, between Imperial Chemical Industries, Ltd., and the I.G. Farbenindustrie Aktiengesellschaft.

The principal reasons for this were, firstly, that since 1912, so far as this country at least is concerned, the range of naphthols of the Naphthol AS group, and a large number of technically important products such as the Rapid Fast Colours, the stabilised diazotised bases, and many of the bases themselves, have been a virtual monopoly of the I.G., though British Synthetics, Ltd., have for some years past manufactured partly under their own patents, and partly by an arrangement with the I.G., certain of these products in this country. Secondly, the case involved an attempt to achieve generally accepted definitions of various fastnesses, including "fastness to kier-boiling," at a time when it was in fact difficult to obtain any common agreement as to the meaning of the term "kier-boiling" itself. Further, for the first time in a chemical patent action, the Court appointed an assessor, and choice was made of Professor Smithells, who is very widely known in the North of England owing to his long associations with the Universities of Manchester and Leeds.

A Well Received Judgment

Mr. Justice Maugham's judgment has been well received and is considered to be an extremely lucid and penetrating statement, and likely to be of great importance in relation to chemical patents in general.

After describing briefly the chemistry of beta oxy naphthoic acid and its arylides, and the possibility of the production of coloured substances by coupling these bodies with diazotised amines, Mr. Justice Maugham summarised the evidence with regard to the state of the art prior to 1922, the date of the patents in question. . . . "It is not in dispute," he says, "that we are dealing here with dyestuffs intended to be used mainly on shirtings and other goods of that character. The untreated grey cotton will first be spun and doubled into two-fold yarn. The portion intended to remain undyed will then go to a master weaver, and the portion that is to be dyed will go to a dyer. Various ranges of colours are dyed, and sent to the manufacturer who then mixes on his yarn loom beam the undyed grey yarn and the dyed stripes of various colours, and the cloth is woven.

Position of the Bleacher

"At this stage the undyed cotton is still grey. In general, it will then go to the cloth bleacher, the bleaching being done subsequently to the weaving, in order that any soiling of the cloth in the course of manufacture may be removed by the subsequent bleaching. The bleacher subjects the cloth to some form of boiling, either a 'kier boil' (that is boiling in a vessel described as a kier) or some other form of boiling. He then chemicks them in a bleaching solution; if necessary in conjunction with a process called souring (to liberate the bleaching agent); and sometimes the process is repeated with another boil and another chemick. The main object of the boiling is to get a good white on the undyed cotton, and to do this it is generally necessary to employ an alkaline solution. . . . It will be perceived, therefore, that it is very desirable, if possible, to employ a dyestuff which, when boiled in a kier with such a solution and for such a period as will give a good white on the undyed cotton, will not suffer deterioration either in depth or tone in the process. As a rule, the manufacturer indicates to the dyer the colour which he is intended to dye, and the dyer may sometimes allow for a slight change of tone as the result of the bleaching by the bleacher. There is bound to be some slight variation in the colour, as the result of the bleaching, perceptible to an expert eye, though perhaps hardly perceptible to the eye of a layman, and a certain amount of latitude is allowed. If, however, the bleacher has been too drastic in his treatment, with the result that the very narrow limits of latitude are passed, he may be made liable for the whole cost of the goods; and he naturally has to be exceedingly careful in the matter. . . ."

Use of Naphthol Colours

One or two comments may be made on the foregoing. The writer thinks that there is some doubt on the point of the principal applications of the Naphthol AS colours, for they were not, either previous to 1922 or since, mainly used on shirtings and other goods of that character. Most of the shades produced from these Naphthols were, previous to 1922 and still are, reds, scarlets, crimsons, garnets, and so on—shades which are not used to any very great extent as stripes in bleached shirtings. The fact is, of course, that these Naphthol Colours were largely used as substitutes for Alizarine and Turkey Reds. In point of view of actual quantity, even before 1922, they were probably most largely used in the towel trade, and in the manufacture of dhooties, and greater quantities were probably made into shirt tabs and similar articles than were put into shirting stripes.

It is also true to say that much larger quantities of single yarns than of two-fold yarns were dyed with these colours.

Substituting Turkey Red

It was probably the need for colours capable of substituting Turkey Red, not only as regards shade and fastness to washing, but also in the towel bleaching processes in which Turkey Red had been used for a great length of time, which influenced the technical chemists of the I.G. prior to their investigations into the fastness to kier-boiling, which led to the Selection Patents of 1922. So far as shirtings were concerned, the Naphthol Colours did find a limited application in filling the gaps in the vat colour ranges, for these, as is well-known, are seriously deficient in good reds, maroons, etc., which can be dyed at a reasonable price. Shirtings with vat colour stripes were never, as His Lordship correctly pointed out, submitted to a caustic boil, but such a process was commonly used in connection with the bleaching of towels, towellings, dhooties, etc., with Turkey Red effects.

Competition Welcomed

The contention of the petitioners (Imperial Chemical Industries, Ltd.) was that by reason of the patents in suit, the I.G. would be able to extend its monopoly of the manufacture of the Azo dyestuffs, and in giving judgment for the petitioners, Mr. Justice Maugham held that the patents were invalid, refused to allow amendments, and ordered the patents to be revoked. It is too early yet to say what is likely to be the effect of these judgments so far as the user is concerned. Most users, whilst appreciating the great service which the I.G. has rendered to dyers and printers in connection with these colours, consider that since 1912 adequate profits have probably been made, and will welcome competition, both as a stimulant to further improvements, and as a factor in reducing prices.

The intentions of I.C.I., Ltd., have not been published to the dyeing trade. If it is their intention to manufacture a range of naphthols and bases comparable with that of the I.G., some time must elapse before marketing on a commercial scale can be achieved.

A further important part of the judgment, namely, the conditions under which Selection Patents can be taken out, has no doubt wide and important implications, but it would not appear that any other class of dyestuffs is in a position comparable with that of the Naphthol AS series.

Dyestuff Licences for March

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during March has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee.

The total number of applications received during the month was 649, of which 569 were from merchants or importers. To these should be added 24 cases outstanding on February 28, 1930, making a total for the month of 673. These were dealt with as follows :—Granted, 625 (of which 596 were dealt with within seven days of receipt) ; referred to British makers of similar products, 37 (of which 33 were dealt with within seven days of receipt) ; outstanding on March 31, 11. Of the total of 673 applications received, 629 or 93 per cent. were dealt with within seven days of receipt.

New I.C.I. Colours

Imperial Chemical Industries, Ltd., issue sample cards of seven new B.D.C. colours, namely, Solochrome Green VS and Black RN, Caledon Claret B Paste, Coomassie Yellow RS, Thionol Indigo Blue 2RS and Sky Blue 6BS, and Chlorazol Yellow 8GS.

Solochrome Green VS, a new member of the B.D.C. range of chrome colours, is a dyestuff of considerable importance for the production of dark green shades where exceptionally good fastness is required. In this connection special mention may be made of the excellent fastness to milling and light on account of which it is eminently suitable for the dyeing of slubbing and loose wool. It possesses good solubility and therefore is suitable for application in the various types of circulating machines. It may be applied by either the afterchrome or the chromate (metachrome) processes, the former process giving the better fastness. It may also be applied by the chrome mordant process.

Solochrome Black RN, dyed as recommended by the afterchrome process, gives full dead blacks which show only a slight change in shade when viewed in artificial light. On this account it is of special interest for the dyeing of men's wear goods, as for instance, dress suitings. It is suitable for the dyeing of materials containing cotton or viscose artificial silk effect threads, as the latter are unstained. Owing to the excellent level dyeing and penetrating properties of this colour, it may be applied to piece goods by starting with 2–3 per cent. sulphuric acid instead of acetic acid.

Caledon Claret B Paste, an addition to the B.D.C range of vat colours, is a homogeneous vat dyestuff which gives bright fast-to-light claret shades of a tone which hitherto could only be obtained by a combination of vat colours. It is specially suitable for the dyeing of cotton piece goods, although it is applicable to all types of cotton materials where fastness to light and washing are required. It possesses good solubility and levelling power and may be applied in circulating machines. Caledon Claret B is applicable to viscose artificial silk, giving clear reddish brown shades of good all-round fastness. In view of the fact that the shade on viscose artificial silk is different from that obtained on cotton, this colour is not recommended for dyeing viscose-cotton union materials.

Coomassie Yellow RS

The outstanding features of Coomassie Yellow RS, an addition to the B.D.C. range of acid colours, are very good fastness to washing, milling, perspiration and light. This dyestuff is specially suitable for the dyeing of loose wool and slubbing, particularly in those cases where the latter is being used for hosiery yarns. It possesses very good affinity for wool and silk from a neutral dye-bath and is suitable for the dyeing of union materials, particularly where good fastness is required. Coomassie Yellow RS is soluble in strongly acid dyebaths and is, therefore, of interest for the dyeing of carbonised wool and shoddy.

Thionol Sky Blue 6 BS and Thionol Indigo Blue 2RS are recommended for their clear bright shades to dyers of all classes of cotton materials. Both are additions to the B.D.C. sulphur colours.

Chlorazol Yellow 8GS, a direct cotton colour, is of particular interest on account of its pure greenish shade, being even brighter and greener than the older brand Chlorazol Yellow 6GS. Bright shades of green are produced with this colour in combination with Chlorazol Sky Blue FFS, which are improved in fastness to light by an after-treatment with copper sulphate. It is suitable for the dyeing of cotton, artificial silk (viscose type) and natural silk, and also unions of cotton and natural silk. It is also suitable for the dyeing of paper.

U.S. Imports of Vat Dyes

Vat dyes constituted the leading class of synthetic colour imports into the United States last year, according to the Tariff Commission. Imports of these dyes amounted to 2,696,124 lb., or 42·06 per cent. of the total, while the next group of colours, acid dyes, amounted to 1,467,379 lb., or 22·89 per cent. of the total brought in.

Total dye imports for the year are given as 6,410,355 lb., with an invoice value of $5,359,058, compared with 5,351,961 lb. and a value of $4,321,867 during 1928. The 1929 imports were the largest for any previous year since 1914, when the United States, still dependent upon foreign manufacturers for its textile dyestuffs, imported 45,950,895 lb., with a value of $9,502,714.

An interesting feature of last year's dye imports was a further falling off in the arrival of basic colours, which amounted to 366,868 lb., or 5·72 per cent. of the total, as against 424,968 lb., or 7·94 per cent. of the total, in 1928.

Increased Swiss Dye Exports

The foreign dye trade of Switzerland during the third quarter of 1929 registered a 10 per cent. increase when compared with the corresponding period of 1928. The increased trade in dyestuffs is accounted for by exports which amounted to 22,067,569 francs in the period July–September, inclusive, 1929, as against 19,580,567 francs in the 1928 third quarter. Imports in the third quarter of 1929 were valued at 5,076,334 francs and in 1928 at 5,077,472 francs.

Studies in Azomethine Azo-Dyes

By R. N. Sen and A. K. Sen

These studies in Azomethine Azo dyes were undertaken at the Chemical Laboratory, Presidency College, Calcutta, by two native chemists, Messrs. Rajendra Nath Sen and Akshoy Kumar Sen, and are reproduced in the journal of the Indian Chemical Society. The death of the latter author took place before the results of the work were published.

FROM a study of the tinctorial properties of a series of azomethine azo-dyes—containing a single azomethine group in the *para*-position to the azo-group but without any auxochromic group in the molecule—prepared by Green and Sen (*J. Chem. Soc.*, 1912, **97**, 2242), it was found that the shade of an azo-dye remains practically unaltered by the introduction of an azomethine group.

The present work has been undertaken for further studies in azomethine azo-dyes in respect of (1) the effect of introducing an additional azomethine group in the *para*-position to the azo-group, and (2) the effect of an auxochrome (OH) in the *para*-position to the azo-group.

A dialdehyde, viz., azo-benzaldehyde sulphonic acid [$CHO{\cdot}C_6H_3(SO_3H){\cdot}N_2{\cdot}C_6H_3(SO_3H){\cdot}CHO$] obtained from "Mikado orange"

$$\begin{matrix} CH{\cdot}C_6H_3(SO_3Na){\cdot}N_2{\cdot}C_6H_3(SO_3Na)CH \\ \| \qquad\qquad\qquad\qquad \| \\ CH{\cdot}C_6H_3(SO_3Na){\cdot}N_2{\cdot}C_6H_3(SO_3Na)CH \end{matrix}$$

in the manner described by Green and Leonhardt (*J. Chem. Soc.*, 1906, **86**, 1613) was selected for the preparation of dyes, containing two azomethine groups in the *para*-positions to the azo-group but without any auxochromic group in the molecule. The dialdehydic nature of the compound has been fully investigated and established in this work, and by its condensation with different amino-compounds and several dyes containing free amino-groups, the first type of dyes has been obtained.

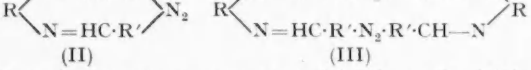
The condensation products of the dialdehyde with several monoamines, such as aniline, α-naphthylamine and β-naphthylamine, produce on wool shades (varying from yellow to brown) considerably lighter than the shade (orange) obtained with the dialdehyde. This shows that the introduction of two azomethine groups makes the colour lighter. This appears to be in perfect agreement with the conclusion arrived at by Sen and Sett (*J. Amer. Chem. Soc.*, 1924, **46**, 111) namely, that too much multiplication of chromophores tends to make the colour lighter. The compounds in the solid state possess colour from yellow to reddish brown and give differently coloured solutions in strong sulphuric acid. The aniline compound gives a yellowish-red solution, the α-naphthylamine compound a reddish-brown solution and the β-naphthylamine compound gives a dark-brown solution, whereas the dialdehyde itself gives an orange-red solution.

The presence of free amino-groups in the condensation product (I) of the dialdehyde with semicarbazide is confirmed by

$$H_2N{\cdot}CO{\cdot}NH{\cdot}N{=}HC{\cdot}R'{\cdot}N_2{\cdot}R'{\cdot}CH{=}N{\cdot}NH{\cdot}CO{\cdot}NH_2$$
$$(R' = C_6H_3{\cdot}SO_3H)$$
(I)

the evolution of nitrogen by the action of nitrous acid. It dyes wool in golden-yellow shade which is lighter than that (orange) produced by the dialdehyde. The compound possesses a yellow colour and gives a yellowish-red solution in concentrated sulphuric acid.

The absence of any free amino- or any free aldehyde group in the condensation products of the dialdehyde with the diamines, namely hydrazine, *o*-phenylene diamine, *p*-phenylene diamine and benzidine, indicates that the aldehyde and the diamine react in molecular proportions with the elimination of two or four molecules of water, giving rise to polymembered ring structures (II or III).

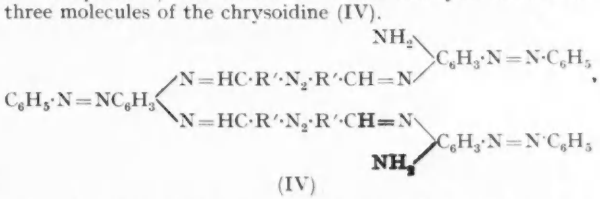


(II) (III)

Such ring structures are supported by the work of Adams, Bullock and Wilson (*J. Amer. Chem. Soc.*, 1923, **45**, 521). The general properties, such as extreme insolubility, and high melting points, referred to in that work, are very similar to those of the condensation products of benzidine and *p*-phenylene diamine with the azo-aldehyde. The molecular weight could not be determined owing to the great insolubility of the compounds, and for the sake of simplicity the structure (II) has been given.

The colour of the compounds obtained by condensing *p*-phenylene diamine and benzidine with the dialdehyde is almost the same, although one contains a phenyl and the other a diphenyl residue. The behaviour of the two compounds towards concentrated sulphuric acid is, however, interesting. The benzidine compound dissolves in sulphuric acid with a violet colour, but on dilution with water a red precipitate is thrown down and the solution becomes colourless; whilst the *p*-phenylene diamine compound produces a red colour in concentrated sulphuric acid, which on dilution changes to light violet. It is very difficult to study the dyeing properties of these compounds owing to their insolubility and ready tendency to hydrolyse. The compound obtained from hydrazine gives a red solution in sulphuric acid and dyes wool in orange shade, while the compound obtained from *o*-phenylene diamine dyes wool in fine canary yellow shade and dissolves in concentrated sulphuric acid with yellowish-red colour. The deepening of colour in the hydrazine compound is presumably due to the presence of the aldazine group (—CH=N—N=CH—).

The dialdehyde has further been condensed with several dyes (containing free amino-groups) such as safranine, rosaniline and chrysoidine, and in every case the colour becomes lighter than that of the original dye. The reactions with safranine and rosaniline are found to occur in molecular proportions and the usual ring formation is also supported in these cases by the absence of free amino- and CHO groups. It is interesting to note that in the case of chrysoidine (with two amino groups in *meta*-position) two molecules of the aldehyde react with three molecules of the chrysoidine (IV).



(IV)

In this connection a noteworthy observation has been made that the dyes rosaniline and safranine can be estimated quantitatively by titrating with a standard solution of the dialdehyde, using phenylhydrazine acetate solution as an external indicator.

With a view to study the effect produced on azomethine azo-dyes by the presence of an auxochromic group (OH), a monoazo-aldehyde with an OH-group in the *para*-position to the azo-group, viz., salicylazobenzaldehyde-sulphonic acid [$CHO{\cdot}C_6H_3(SO_3H){\cdot}N_2{\cdot}C_6H_3{\cdot}(OH)\ COOH$] has been prepared from "Hessian yellow."

$$\begin{matrix} CH{\cdot}C_6H_3(SO_3Na){\cdot}N_2{\cdot}C_6H_3(OH){\cdot}COOH \\ \| \\ CH{\cdot}C_6H_3(SO_3Na){\cdot}N_2{\cdot}C_6H_3(OH){\cdot}COOH \end{matrix}$$

A few compounds were obtained by the condensation of the monoazoaldehyde with amino-compounds. By way of comparison it may be noted that they produce on wool similar shades as those obtained from the corresponding compounds of phenetoleazobenzaldehyde-sulphonic acid (Green and Sen).

Thus from a study of the compounds described in this paper it is found that in azomethine azo-dyes—(1) the effect of introducing an additional azomethine group in the *para*-position to the azo-group lightens the colour more or less, except in the case of two azomethine groups in juxtaposition, constituting the aldazine group which deepens in colour; (2) the presence of an auxochromic group (OH) in the *para*-position to the azo-group, like the auxochrome in the *para*-position to the azomethine group (previously studied by Green and Sen) has practically no effect.

Experimental

(A) *Sodium* p : p'-*Dialdehydo-azobenzene*-m : m'*disulphonate.*

To a filtered solution of "Mikado orange" (40 g.) in boiling water (2·5 litres), cooled to 0–5°, a 3 per cent. solution of potassium permanganate (2·36 g.) is added gradually until a permanent pink colour is obtained, the solution being mechanically stirred during the addition. After the reaction is complete the solution is boiled, filtered from the manganese dioxide sludge and the residue repeatedly extracted with hot water. After neutralisation by hydrochloric acid, the combined filtrates are concentrated to a small bulk on the water-bath and the sodium salt of the sulphonic acid precipitated by the addition of common salt. The sodium salt is collected, washed with alcohol (50 per cent.) and purified by crystallisation from dilute alcohol, when it is obtained in buff-coloured microscopic needles. A further quantity of less pure material can be obtained by the further addition of common salt to the original filtrate (yield, 67·5 per cent.). The disodium salt is readily soluble in water and the sulphonic acid is not precipitated by the addition of acid. On treatment with phenylhydrazine it yields a reddish-brown phenylhydrazone. It dissolves in sulphuric acid yielding an orange-red solution which on dilution becomes orange and finally yellow. It dyes wool an orange shade. (Found: N, 6·29, 6·34; S, 14·65, 14·77. $C_{14}H_8O_8N_2S_2Na_2$ requires N, 6·33; S, 14·48 per cent.)

The *barium salt* is insoluble in cold water and slightly soluble in hot water. (Found: Ba, 25·91, 25·94; N, 5·17, 5·20. $C_{14}H_8O_4N_2S_2Ba$ requires Ba, 25·75; N, 5·24 per cent.)

A determination of the aldehyde groups is effected by titrating with a standard solution of phenylhydrazine hydrochloride in presence of sodium acetate, employing phenetoleazobenzaldehydesulphonic acid as an external indicator. (Found: CHO, 13, 12·8. $C_{14}H_4O_8N_2S_2Na_2$ requires CHO, 13·12 per cent.)

Preparation of the Azomethine Azo-dyes

(1) *Condensation product with semicarbazide* is prepared in the usual manner and is crystallised from hot water. It is a yellow substance, moderately soluble in cold water, soluble in concentrated sulphuric acid with a yellowish-red colour which changes to yellow on dilution; it dyes wool in golden-yellow shade. (Found: N, 20·09, 19·98. $C_{16}H_{14}O_8N_8S_2Na_2$ requires N, 20·14 per cent.)

(2) *Condensation product with aniline.*—A hot solution of aniline (1·4 c.c.) in dilute acetic acid is slowly added to a hot aqueous solution of the aldehyde (3 g.), the mixture being stirred all the time and the reaction completed by warming for a short time. The yellow precipitate, thus obtained, is filtered off, washed with dilute acetic acid and is crystallised from hot water. It is a yellow powder, sparingly soluble in cold water, soluble in concentrated sulphuric acid with a yellowish-red colour, which changes to yellow on dilution; dyes wool a yellow shade. (Found: N, 9·57, 9·64. $C_{26}H_{18}O_6N_4S_2Na_2$ requires N, 9·46 per cent.)

Other condensation products with the mono-amines are listed in Table A.

(3) *Condensation product with benzidine.*—To a cold acidified aqueous solution of the aldehyde (4 g.) a solution of benzidine (1 per cent.) in hydrochloric acid is slowly added till the solution is almost colourless, when a dark-brown precipitate separates in the cold. The precipitate is filtered off, thoroughly washed with dilute hydrochloric acid, then with hot water and hot alcohol and dried; the free compound, thus obtained, is dark-brown, insoluble in hot water, slightly soluble in caustic alkalis, practically insoluble in hydrochloric acid, which hydrolyses the compound on heating. It is sparingly soluble in alcohol, and practically insoluble in other organic solvent, soluble in concentrated sulphuric acid with a violet colour and on dilution a red precipitate is thrown down; it dyes wool a brownish-yellow shade. (Found: N, 10·03, 9·89. $C_{26}H_{18}O_6N_4S_2$ requires N, 10·25 per cent.)

TABLE A.

	Formula.	Preparation.	Analysis. Found.%	Calc.%	Shade on wool.	Properties.
(5)	$C_{24}H_{22}O_6N_4S_2Na_2$	Aqueous solution of the dialdehyde (3 g.)+alcoholic solution of β-naphthylamine (1·9 g.) on the water-bath.	N, 8·0 8·01	N, 8·09	Greyish-orange.	Crystallised from dilute alcohol; a bright orange powder, moderately soluble in cold water, soluble in conc. sulphuric acid (dark-brown solution).
(6)	$C_{34}H_{24}O_6N_4S_2$	Aqueous solution of the dialdehyde (2·21 g.)+a solution of α-naphthylamine (1·43 g.) in dilute hydrochloric acid on the water bath.	N, 8·54, 8·62	N, 8·64	Brown.	Crystallised from dilute alcohol; the free compound is reddish-brown, slightly soluble in hot water, readily in alcohol.
(7)	$C_{20}H_{12}O_6N_4S_2Na_2$	The dialdehyde (3·31 g.)+*o*-phenylene diamine (·8 g.)+glacial acetic acid on the water-bath.	N, 10·86, 10·82	N, 10·89	Fine canary yellow.	Crystallised from dilute alcohol; yellow powder with a slight orange tinge; sparingly soluble in cold water, soluble in conc. sulphuric acid (yellowish-red, changing to yellow on dilution).
(8)	$C_{20}H_{14}O_6N_4S_2$	By mixing molecular proportions of acidified solution of the dialdehyde and *o*-phenylene diamine in the cold.	N, 11·81, 11·72	N, 11·91	Chocolate.	Reddish-brown free compound, insoluble in water, slightly soluble in caustic alkalis, sparingly in hot alcohol, soluble in concentrated sulphuric acid (red, changing to violet on dilution).
(9)	$C_{14}H_8O_6N_4S_2Na_2$	Aqueous solution of hydrazine sulphate (0·64 g.) and dialdehyde (2·3 g.) on the water bath.	N, 12·74, 12·66	N, 12·79	Bright orange.	Deep orange sodium salt, fairly soluble in cold water, soluble in concentrated sulphuric acid (red, changing to yellow on dilution.
(10)	$C_{32}H_{22}O_6N_6S_2$	The dialdehyde+rosaniline hydrochloride in the same manner as in (4).	N, 10·44, 10·46	N, 10·7	Bluish-red.	The free compound has a deep chocolate colour, moderately soluble in hot water, easily soluble in alcohol, soluble in concentrated sulphuric acid (brownish-red).
(11)	$C_{24}H_{26}O_7N_6S_2$	The dialdehyde+safranine in the same manner as in (4).	N, 12·34, 12·26	N, 12·10	Red.	The free compound is a chocolate-coloured powder, moderately soluble in hot water and in alcohol.

TABLE B.

	Formula.	Preparation.	Analysis. Found. %	Analysis. Calc. %	Shade on wool.	Properties.
(1)	$C_{20}H_{15}O_6N_3S$	The aldehyde + aniline acetate.	N, 9·85, 10·06	N, 9·88	Fast yellow.	Yellow powder, readily soluble in alcohol, sparingly soluble in cold water.
(2)	$C_{40}H_{28}O_{12}N_6S_2$	The aldehyde + benzidine hydrochloride.	N, 9·83, 9·94	N, 9·91	Yellow.	Reddish-orange powder, slightly soluble in water and moderately in hot alcohol.
(3)	$C_{49}H_{29}O_{12}N_5S_2$	The aldehyde + chrysoidine hydrochloride.	N, 12·88, 12·89	N, 12·78	Yellow.	Red colour, slightly soluble in water, easily soluble in hot alcohol.
(4)	$C_{47}H_{33}O_{12}N_7S_2$	The aldehyde + rosaniline hydrochloride.	N, 10·14 10·23	N, 10·29	Bluish-red.	Deep chocolate colour, sparingly soluble in cold water, freely soluble in hot alcohol.
(5)	$C_{45}H_{36}O_{12}N_8S_2$	The aldehyde + safranine hydrochloride.	N, 11·32, 11·34	N, 11·23	Red (slightly orange).	Chocolate colour, slightly soluble in hot water, but more soluble in alcohol.

Other condensation products with the diamines are listed in Table A.

(4) *Condensation product with chrysoidine.*—A hot aqueous solution of the aldehyde (4 g.) is added drop by drop to a solution of chrysoidine (3 g.) in dilute hydrochloric acid, heated to 70-80 deg. The solution is then vigorously stirred until it is cold. The precipitate, thus obtained, is filtered, washed with hot water and hot alcohol; the free compound, thus obtained, is a scarlet powder, insoluble in water and in acid, slightly soluble in caustic alkalis. It dissolves in concentrated sulphuric acid with a scarlet-red colour changing to reddish-orange on dilution; it dyes wool a yellow shade. (Found: N, 16·26, 16·31; S, 9·32. $C_{64}H_{48}O_{12}N_{16}S_4$ requires N, 16·47; S, 9·40 per cent.)

Condensation products with safranine and rosaniline are listed in Table A.

(B) *Sodium Salicylazobenzaldehydesulphonate.*

It was prepared by the oxidation of a solution of "Hessian yellow" (Merck) (30 g.) in water (3 litres) with potassium permanganate solution (3 per cent., 6·6 g.) in the manner described in the preparation of the dialdehyde. The isolaton and the purification of the compound was similarly carried out (yield, 70 per cent.). The free compound, obtained as reddish-orange microscopic needles by crystallising the sodium salt from hot water acidified with hydrochloric acid, is moderately soluble in cold water. It reacts very easily with phenylhydrazine producing an orange phenylhydrazone. It dissolves in concentrated sulphuric acid with a red colour, which on dilution changes to yellow; sodium hydroxide solution produces a deep red coloration; it dyes wool an orange (slightly yellowish) shade. (Found: N, 7·96, 8·04; S, 9·24. $C_{11}H_{10}O_7N_2S$ requires N, 8·0; S, 9·14 per cent.)

A determination of the aldehyde group is effected in the manner described in the case of the dialdehyde. (Found: CHO, 8·19, 8·27. $C_{11}H_{10}O_7N_2S$ requires CHO, 8·20 per cent.)

The azomethine azo-dyestuffs prepared from the monoaldehyde are listed in Table B.

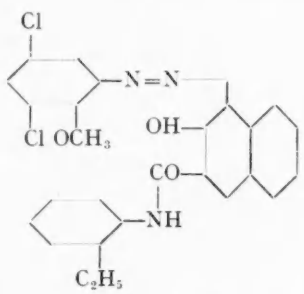
Dyes and Their Application: Recent Technical Progress

By L. J. Hooley

Insoluble Azo Colours

THE recent dyestuffs action, with the judgment revoking three patents of the I.G. Farbenindustrie Akt.-Ges., has directed special attention to the insoluble azo colours obtained by coupling diazo bodies with arylides of 2 : 3-hydroxy naphthoic acid, which are a sub-group of the insoluble azo colours. In the following, some of the most recent of the many developments which have taken place during the last few years will be described. Except where otherwise mentioned, the patents are of the I.G. Farbenindustrie Akt.-Ges.

The production of new substituted amines for coupling with the naphthols continues. Thus in B.P. 302,599 dihalogen-2-amino-toluenes are used, the halogens being such that one is in the 4-position and at least one is bromine. Again, in B.P. 302,251 a dihalogen-2-anisidide is used, one of the two halogen atoms being in the 4-position to the methoxy group, the body shown below being one illustrated in the patent.



Further, in B.P. 298,907 a 2 : 5-dimethyl-4-halogen-1-amino-benzene is used. Still another patent of the same type, B.P. 287,908, makes use of p-toluidines containing halogen in positions 2 : 3- or 2 : 5, again one halogen atom at least being bromine. The shades obtained are in general red and the products are stated to be fast to light.

By far the greatest majority of the present-day new azo development colours make use of arylides of 2 : 3-hydroxy-naphthoic acids. Other hydroxy derivatives may, however, be used, and among recent examples are to be found diacetoacetyl diamino diaryl compounds (B.P. 323,927). As an example, diacetoacetyl o-toluidine coupled with 2 : 3 : 4-trichloraniline gives a yellow.

Cyano Derivatives

In B.P. 301,410 cyano-arylamines are diazotised and then coupled with suitable components such as, for example, the 4-chlor-o-anisidide of 2 : 3-hydroxy-naphthoic acid.

Nitroso Diphenylamine Derivatives

A variety of blue shades can be obtained by treating a p-amino-diphenylamine with excess of nitrous acid, coupling the nitroso diazo body with arylides of 2 : 3-hydroxy-naphthoic acid, and then, after coupling, boiling with sodium sulphide to remove the nitroso group. Alternatively, if the nitroso group is not removed violet to garnet shades are obtained (B.P. 313,865). The nitroso derivatives have the following constitution :—

$C_6H_5.N.(NO).C_6H_4.N : N.C_{10}H_5(OH)CONH.Ar.$

In B.P. 307,890 the preparation of stable diazo preparations of nitroso diazo solutions of unsulphonated p-amino-diphenylamine compounds is described. Amino-diphenylamine, among other bases, is also used as a component in B.P. 311,400, where the naphthol chosen is 2 : 3-hydroxy-naphthoic acid-2^1-methyl-5^1-isopropyl-1^1-anilide.

Disazo Dyes

Although the bulk of the dyes of the Naphthol AS type are monazo dyes, disazo and the more complicated colours have also been described, and these are especially necessary for

black or other deep shades. In B.P. 275,147 (Rohner) a mono-oxalyl derivative of benzidine, tolidine, etc., is coupled with an amino component, hydrolysed, and the resulting diamine tetrazotised and coupled with the α-naphthylamide of 2 : 3-hydroxy-naphthoic acid to give a black.

$C_6H_4.N:N.C_{10}H_6.N:N.C_{10}H_5.(OH).CONH.C_{10}H_7$
|
$C_6H_4.N:N.C_{10}H_5.(OH).CONH.C_{10}H_7$

Another black is obtained in U.S.P. 1,635,594 (Grasselli), where, for example, diazotised p-phenylene diamine is coupled with β-naphthol and the diazotised product is further coupled with the 5-chlor-2-toluidide of 2 : 3-hydroxy-naphthoic acid.

One of the most recent patents (B.P. 318,882) describes soluble disazo dyestuffs ; an arylide of 2 : 3-hydroxy-naphthoic acid is coupled with a diazotised amino-azo compound of the general formula

$$\left[R_1-N=N-R_2\right]\begin{matrix}-NH_2\\-SO_3H\\-X\end{matrix}$$

in which R_1 and R_2 are aryl residues and X means a sulphonic or a carboxylic group. The products described are largely blacks and stated to have good fastness to washing, hot pressing and light. In an example, naphthionic acid is coupled with Cleve's acid and this with the p-anisidide of 2 : 3-hydroxy-naphthoic acid.

Alkyloxy and Aryloxy Derivatives

Ether groups may be used as substituents in either part of the molecule. Thus, in B.P. 248,766 a 2-amino-4-aroylamine diaryl ether is used. In B.P. 256,272 esters of 4-nitroanthranilic acid are used, thus Naphthol AS with a methyl ester gives a bluish red pigment. In B.P. 309,879 the alkoxy group is in the arylido part, thus 3-alkoxy-β-naphthylamides of 2 : 3-hydroxy-naphthoic acid are obtained, and these have good affinity for the fibre so that the padded fibre can be rinsed to give colours fast to rubbing. In B.P. 317,530 amino naphthol ethers are coupled with the arylides. The production of amino naphthol ethers is described in B.P. 304,441, this being done by alkylating the hydroxy carboxyamide and following by Hoffman's reaction. Finally, in B.P. 319,247 alkyl esters of 5-halogen-2-amino-1-benzoic acid are used.

Among more miscellaneous matters may be mentioned B.P. 315,666, where esters and amides of 2 : 3-amino-naphthoic acid are prepared, the method being from 2 : 3-naphthisatoic anhydride by treatment with an alcohol and a base.

Green yellow dyes suitable for oils can be obtained from an acetoacetic acid amide by coupling with p-amino acetophenone, p-amino-benzophenone or a meta-nitro derivative of this B.P. 307,104.

Sulphonated fatty acids from wool fats are recommended for solubilising solutions of 2 : 3-hydroxy-naphthoic arylides. Those chosen should form clear pseudo solutions either in acid, neutral or alkaline solution (B.P. 307,777).

An interesting light on the possible condition of colours of the Naphthol type within the fibre is thrown by the work of G. Schwen (*Textilber.* **9**, 673). The author used the colour to dye cellophane. With Naphthol AS SW 0·1 gm. per litre (and Fast Red KB base), the cellophane was transparent, showing only a few particles in the ultra microscope. With stronger solutions of Naphthol the cellophane became slightly opalescent, while a boiling treatment gave considerable quantities of visible particles and cloudiness.

Acetate Products Corporation

THE accounts of the Acetate Products Corporation for the period August 15, 1928, to November 30, 1929, show a loss on trading of £5,289, and a net loss for the period of £12,196. In addition to this loss the assets in the balance sheet include preliminary and formation expenses, £70,068. The report states that substantial economies have been made, the full effect of which will be experienced during the current year. The auditor's report contains a number of observations, including the following :—" We are not satisfied that the following assets which appear in the balance sheet at cost are of the values stated : patents and trade marks, £33,203 ; cost of the benefit of contracts taken over, £55,026 ; goodwill, £85,000."

Scottish Market Report

Orders Still Short

MARCH has been another rather unsatisfactory month, although conditions improved slightly towards the end. Dyers and printers generally in Scotland have been finding the conditions in the textile trade reflected in their own orders, which are still on the short side

The woollen trade in the south is not yet showing any signs of recovering its prosperity of a short time ago. Export orders from America and the Colonies have been rather small, and although those from Germany and Central Europe have been better they still leave something to be desired ; the fall in the price of wool has been another disturbing factor, and throughout the industry there are few manufacturers who have been able to keep the whole of their looms running, while in some cases considerably less than 50 per cent. of the machinery has been active.

An example of the bad position in the textile industry is to be found in the news that J. H. Young and Co., Ltd., of Glasgow, who have been established about 100 years as manufacturers of muslins, Madras goods, etc., intend to close down. Although in pre-war days the number of hands employed was several hundred, latterly it was only about two hundred.

An interesting item of news to those in the textile trades in Scotland as well as to many others is the decision of the Senate of St. Andrew's University to confer the honorary degree of LL.D. on Mr. James Morton. Apart from his pioneer work in connection with the use and making of fast dyes which can be seen in the founding and establishment of Morton's Sundour Fabrics and Scottish Dyes, Mr. James Morton has many other interests in textiles and comes of a family which has done a great deal for Scotland in the establishment of new industries.

British Tintex and Dyes

Mr. V. Dunhill on Prospects

THE general meeting of British Tintex and Dye Products, Ltd., was held at the registered offices, Regent Street, W.1, Mr. Vernon Dunhill presiding.

The Chairman said the profit and loss account showed the gross profit on trading for a period of eleven months, whereas the expenses covered a period of fourteen months. As regards the development of the business, the introduction of a new line into a highly competitive field was no easy matter. Despite the difficulties encountered, the directors felt that in the eleven months under review, a sound foundation had been laid for future development. There was no doubt that the appeal made to the public, through advertising, was producing the desired result, and it was proposed to continue the same steady policy of development which up to now had been very carefully followed. Overseas, good progress was being made, particularly in Australia and New Zealand.

Mr. Foster, a shareholder, expressed his opinion that the promises of the prospectus had not been fully carried out. He regretted to see that certain directors had retired from the board, and he also was surprised to find that some of the directors had been selling shares of the company. He pointed out that the shares of the company had had a large rise, and he wondered whether they could attribute the selling of the shares to the higher price obtainable.

The general manager, Mr. P. H. Ellis, stated that it was most gratifying to be able to announce that the repeat orders represented 87 per cent. of the turnover this year.

The resolution for the adoption of the report was lost on a show of hands.

Subsequently, to avoid a poll, an amendment was put forward that the report and accounts should be adopted with the provision that a committee of shareholders be appointed to confer with the board.

The Chairman said that he felt that on reconsideration the shareholders would alter their views. Personally he had not the slightest objection to the appointment of the committee.

It was then decided to put again the resolution adopting the report and accounts. It was carried by an overwhelming majority.

The committee was duly elected and the retiring directors and auditors, Messrs. Price, Waterhouse and Co., were re-elected.

Dyestuffs Monthly Supplement

Published in the second issue of "The Chemical Age" each month

Communications relating to editorial matter for the Dyestuffs Monthly Supplement should be addressed to the Editor, THE CHEMICAL AGE, *Bouverie House, 154, Fleet Street, London, E.C.4. Advertisement matter, subscriptions, etc., should be sent to the Manager. The Supplement is devoted to the interests of both manufacturers and users of dyestuffs, and contributions will be welcomed.*

The Dyestuffs Action

THE period granted by Mr. Justice Maugham to the I.G. Farbenindustrie to consider the question of appealing against his judgment in the recent dyestuffs patent action expired last week, and as the I.G., according to our information, has not entered any notice of appeal, the judgment will now stand. Lord Melchett, in his speech at the annual meeting of Imperial Chemical Industries, referred to the judgment as fully confirming the advice given by the technical experts of the company, and congratulated the company and their advisers on the result of the action. Reference is made to the subject in our leader notes.

Lord Melchett and the Dyestuffs Industry

Lord Melchett's speech at the annual meeting of Imperial Chemical Industries disposes of the impression—based on a casual remark he once made at a dinner—that he regards the dyestuffs industry as comparatively small and unimportant. Small, no doubt, it is in relation to other branches of chemical organisation, but in value—both to the home textile industry and as guaranteeing the existence of a school of organic chemistry—it is not surpassed by any. With equal truth it may be said that in the post-war period no advance—with the possible exception of the fixed nitrogen industry—is comparable to the advance made in dyestuffs research and production. Before the war, the home industry was almost negligible; it was, as the textile industry quickly found on the outbreak of war, hopelessly inadequate to home needs. Within the short period of ten years the position has been completely reversed. According to Lord Melchett's figures, the British dye industry to-day produces of weight 93 per cent. and by money value 72 per cent. of the dyestuffs consumed in this country. When war broke out and the textile makers of Lancashire and Yorkshire found their supplies of essential colours suddenly cut off, no class was more insistent on the provision, at whatever cost, of a home industry capable of meeting home demands. Yet from the same quarter now comes an ardent demand for the discontinuance of the Act, without any real inquiry into present conditions. A Burnley manufacturer was reported the other day to have stated that "the Lancashire cotton industry has lost millions of pounds worth of trade because the price we have had to pay for dyes in this country has made our goods too dear." Similar wild assertions have repeatedly been made, but no authentic statistics have yet been produced in support. On the contrary, it has been shown again and again that a difference in the price of the dyestuff in relation to the total cost of the finished article is so fractional as to be without effect on the price, and when the price factor has been reduced its effect again has been too fractional for the dyers to pass it on to the customer. When one compares any slight handicap involved in the application of a price factor with the enormous gains to the country resulting from the existence of an efficient home dyestuffs industry, there should be little difficulty in seeing on which side the balance lies.

Dyestuffs Production

The figures published by the Board of Trade a fortnight ago show that the total British output of dyestuffs amounted to 55,785,032 lb. in 1929. What is especially notable is that of this total no less than 14,683,701 lb. is represented by vat dyestuffs, of which this country produced in pre-war days practically nothing, depending on foreign supplies that were cut off when war was declared. The available figures now cover the six years 1924 to 1929, inclusive. These show that the total output has advanced from 14,880 to 24,900 tons. With the single exception of sulphur colours, every class of colour is represented in the increase—vat colours from 2,234 to 6,555 tons; direct cotton colours from 2,259 to 3,308 tons; acid wool colours from 2,318 to 3,315 tons; chrome and mordant colours from 3,094 to 4,292 tons; basic colours from 700 to 1,138 tons; lake-making dyestuffs from 337 to 832 tons; cellulose acetate silk, oil, spirit and wax colours, etc., from 401 to 2,407 tons. No class should be more appreciative than the textile manufacturers themselves of the technical ability, commercial organisation, and heavy expenditure which have contributed to these truly remarkable results. When one takes into account the cost of the production of even one new dye, the expenditure that has to be incurred in research and experiment before it can be safely put on the market, and the time it takes the manufacturer to obtain a fair return on this outlay, the moderation of Lord Melchett's claim, that an industry that has accomplished so much for the nation is entitled to the most sympathetic consideration, must be readily recognised.

A New Solazol Series

Scottish Dyes, Ltd., announce (through Imperial Chemical Industries) the production of Solazol Red 2B, the first member of a new series—the Solazols. These are an entirely new type of azo dye, in fastness similar to the naphthols, but without their difficulty of application. They are equally applicable to cotton, wool, and silk and artificial silk, and can be dyed from direct baths, the ultimate shade being developed by an acid oxidising treatment. They are readily soluble in water and have a fairly high substantive affinity for all types of fibre, so that they can be applied both by padding methods and from long baths. In the case of the latter, exhaustion may be assisted by the addition of salt, as in the case of the direct cotton colours.

The printing process presents little difficulty, the colour being merely fixed with a gum thickening and applied direct to the fibre. Fixation takes place on steaming, the final shade being developed by an acid oxidising treatment in the same way as when dyeing or padding. Additions to the printing paste, such as glycerine and olive oil, are recommended. The application of these soluble colours on the large scale presents no difficulty, the conditions being adapted to suit the plant available.

As regards development, one of the best methods for animal fibres is treatment in a 2 per cent. potassium persulphate solution acidified with 1 per cent. sulphuric acid at a temperature of 80° to 100° C. for silk, and rather lower for wool. For cotton or viscose, acid ferric chloride or sodium nitrite can be used. Complete development should take place after about two minutes' immersion. A soap treatment is necessary to attain the correct shade and fastness. This can be a boiling soap treatment in the case of

cotton and silk, and a correspondingly milder treatment for wool.

Solazol Red 2B is being offered in the form of a paste. It gives bright bluish shades of red. In fastness to light, it is equal to the best of the naphthol reds. The colour will withstand a soda ash kier boil in the presence of Resist Salt L. Detailed instructions for cotton and wool dyeing and printing are given in the colour card. They are easily discharged white with alkali or an alkaline reducing agent.

A Trade Mark Change

Although the British Dyestuffs Corporation is merged in Imperial Chemical Industries, its colours have hitherto been marketed under "B.D.C.," the trade mark of the Corporation. This has apparently been discontinued and the colour cards now bear the mark "I.C.I." The first new colours issued in this form are Dispersol Fast Orange B S Paste and Chlorazol Fast Scarlet 4BAS.

The first-named colour, a very beautiful shade of orange, is an addition to the I.C.I. range of colours for cellulose-acetate artificial silk. It is applicable to all types of cellulose-acetate silk and to mixed goods containing cellulose-acetate silk. It gives yellowish orange shades possessing very good all-round fastness, particularly excellent fastness to light. It is dyed in the same manner as for Duranol colours, at a temperature of 75–85° C. (165–185° F.). from a bath containing Turkey Red Oil or other soluble oil. When used in combination with other colours, as when dyeing mixed materials containing cellulose-acetate silk, acetic acid, alkali, salt, etc., may be added if necessary.

Chlorazol Fast Scarlet 4BAS, an addition to the company's range of direct cotton colours, is suitable for application to all types of cotton materials for the production of bright scarlet shades of good fastness to light, water, washing, perspiration and particularly good fastness to acids. Its outstanding features are exceptionally good solubility and levelling power, which makes this colour eminently suitable for machine dyeing. It is of value for dyeing viscose-artificial silk, as it is superior to the average direct scarlet for giving even shades on material of irregular quality. It does not stain cellulose-acetate silk and therefore is suitable for dyeing the cotton or viscose-artificial silk in acetate silk union materials. It is applicable to wool-cotton unions where it is required to dye the cotton in a lukewarm bath and leave the wool undyed. It is suitable for the production of dischargeable ground shades and for paper dyeing.

New D.B.C. Colours

Three colours, issued by Imperial Chemical Industries, but retaining the old "B D C" trade mark, are Coomassie Yellow OS and Lissamine Fast Navy 2G, both additions to the existing range of acid colours, and Monolite Yellow TS Powder. Coomassie Yellow OS is a bright acid yellow of good covering power, one of the fastest colours of its class in respect to washing, milling, perspiration and light. The possession of these properties makes this colour of considerable value for the dyeing of loose wool and slubbing, particularly as it is suitable for application in conjunction with chrome dyestuffs. It is also of interest for dyeing fabrics such as mohair linings, where particularly good fastness to perspiration is an essential feature. The colour possesses good solubility, being suitable for application in the various types of circulating machines.

Lissamine Fast Navy 2G, though primarily intended for the dyeing of woollen piece goods, is also of interest for the dyeing of woollen yarn. It is an easy levelling colour and possesses fastness to light well above the average for its class. Cotton or artificial silk (viscose type) effect threads are left unstained in the dyeing process.

Monolite Yellow TS Powder is a printing ink colour that has been placed on the market specially to meet the demand for a pigment yellow possessing very good transparency, coupled with high-grade fastness properties. In shade and general fastness properties it closely resembles Monolite Yellow GS Lumps, but, unlike the latter product, possesses good transparency. Monolite Yellow TS Powder will, therefore, be found extremely useful for purposes where the use of Monolite Yellow GS Lumps is prohibited on account of its opacity or covering power. The chief outlets for Monolite Yellow TS Powder will be in the manufacture of certain classes of fast-to-light printing inks for use in three-colour printing, tin-plate printing, or wherever a high degree of transparency is an essential property. In addition, this product will find use in the manufacture of varnishes and nitro-cellulose lacquers. The colour is insoluble in water, and requires no precipitating agent. It is simply ground, with or without a substratum, into the required medium. The colour card shows the two colours named overprinted on black.

India's Dyestuff Imports

Imports of coal tar dyestuffs into India during 1929, our Indian correspondent writes, fell from 20 million lb. to 18 million lb., the value decreasing from 245 lakhs to 180 lakhs. Alizarine dyes were valued at Rs. 28 lakhs and were 5·7 million lb. in volume. Aniline dyes amounted to 12 million lb. in volume as against 14 million lb. in the previous year. The imports from the United Kingdom of both alizarine and aniline dyestuffs rose, though slightly, the former from 1·1 to 1·2 million lb., and the latter from 500,000 to 800,000 lb. Imports of alizarine from Germany rose from 3·4 to 3·9 million lb., but those of aniline fell from 10 to 8 million lb. Of the total quantity of dyes imported, Bombay consumed 13 million lb., and Madras 2 million lb.

Reparation Dyestuffs Profits

An interesting case is coming on shortly in the United States courts over the profits made through the sale of German reparation dyestuffs. These sales were undertaken by a non-profit making corporation known as the Textile Alliance, which, as the result of its trading operation in dyestuffs for a period of about ten years, hasaccumulated earnings amounting to $1,800,000. The dyestuffs, of course, were set aside under the Treaty of Versailles as a part of the reparations from Germany, but the disposal of the funds so accumulated has been a problem because the United States refused to accept such reparations. The Alliance entered into a contract with the Government in 1920 to handle these dyestuffs, but from the first there has been a question as to the legal status of the monies received from their sale, and it has now been decided that the Government should begin a friendly suit with the idea that the funds shall be allocated by the Federal authorities to an educational and research fund for the benefit of the American textile industry. President Hoover favoured this solution when he was Secretary of Commerce. The Textile Alliance has announced that it does not intend to contest the suit, being itself desirous that the money in hand should be applied to educational purposes.

Decreased German Dye Profits

The annual report of the I.G. Farbenindustrie shows a net profit of 104,600,000 marks, as compared with 118,450,000 marks in the previous year. Last year's dividend of 12 per cent. will be maintained, and there will be an additional bonus of 2 per cent.

Position of the British Dyestuffs Industry

*By Lord Melchett**

THE first subject with which I will deal is the present position of our dye industry, which becomes of special interest as the Dyestuffs Act, which was passed in December, 1920, and under which the British Dyestuffs Corporation was originally founded, expires in January, 1931, unless by the intervention of Parliament new legislation is passed.

Most of you will remember the circumstances under which this Act was passed, and the British Dyestuffs Corporation came into existence. It was an aftermath of the war during which, by bitter experience, we had learnt the folly of depending practically for our entire dye supplies on foreign and, as it then happened, on enemy resources. It was universally felt that such a risk could not be undertaken again, and a unique piece of legislation for the creation of a new and difficult industry by prohibiting, except under licence, the importation of foreign dyestuffs became the law of the land.

The creation of this industry was no light task. Of all the many branches of chemical activity there is none more complicated or detailed than the manufacture of dyes and the many other products related to them. They call for the creation of staffs of researchers and works managers in a branch of organic chemistry in which we had been woefully deficient. We were called on to take part in the race in which our competitors had advantages of generations of previous experience, equipment, sales organisation, and services.

Difficult Early Years

It is not surprising that the first years of this company were years of difficulty and disappointment. In fact, it can be more accurately described as a national work rather than a remunerative commercial industrial enterprise. I make no secret of the fact that when we formed the I.C.I. merger there was some hesitation about including this branch of chemical activity. We really only included it because we felt it our duty to bring to bear the knowledge, resources, and assistance in the possession of our various groups, and it was impossible to conceive that an important branch of the chemical industry vital for national defence and important to our textile industries should be allowed to remain in an undefended position without the powerful aid we were able to bring to it.

As you know, we have only had three years in which to tackle all the various problems connected with this enterprise. We have had to operate during a time when the world increase of plant consequent on the war and the manufacture of dyes both in Europe and America induced the demoralisation of the market, which turned an industry which was formerly a gold mine to its owners into what was universally found and recognised to be a somewhat unremunerative proposition.

I am glad to think that during that period we have made an altogether surprising amount of progress, more especially in the last two years, which has been very largely due to the unremitting zeal and energy of my colleague, Mr. J. Rogers, one of our technical directors, who has been devoting his energy and ability towards improving methods, reducing costs, and co-ordinating the efforts of our various factories for the production of new lines of dyes which are so essential in order to keep in the world competition of to-day.

Enormous Range of Dyes

The range of dyes required for the various purposes of modern industry is enormous. There are over 10,000 separate dyestuffs known, and while a great many are redundant, this figure serves to show the complexity of the industry. We are to-day manufacturing dyes of a quality equal to those made by any other firm in the world, and no customer of ours has any longer any reason to complain, as undoubtedly was the case in the earlier days, regarding quality.

We have reduced prices to figures which enable the English consumer to obtain his products at world prices. We are placing new lines on the market, which compare favourably with those produced by any of our competitors. We have entirely reorganised the method of our sales, both at home and abroad, and are making substantial progress in the development of our export trade, which was practically non-existent.

Your attention may have been called to the important result of the litigation we have been reluctantly compelled to undertake against the I.G. for the revocation of a series of patents taken out by them in this country, and which debarred us from a large field. The judgment in that action went entirely and completely in our favour, and fully justified the advice of our technical experts. This opens up a large new and fruitful field for development which we are now pursuing. It entirely justifies the expense of the litigation which, I may say, has been ridiculously exaggerated, and which, as successful litigants, we shall recover practically in full from our opponents.

Training of Chemists

I can say that we are now on the highway to success. We have enlisted in our ranks during the year the assistance of some of the ablest brains among the professors of organic chemistry in this country. We are training up the staff of organic chemists which we require, both for manufacture and for technical advice to our customers. We are making increasing profits in spite of severe competition and reduced prices in this branch of our business.

While we have every reason to be satisfied with the progress we have made, we have only had a very short time at our disposal to consolidate and develop the position of this industry, and I should like to point out, as it is not commonly understood, that the dye industry is not merely concerned with the manufacture of colours, but it is essentially necessary for the development of the organic chemical industry of a country and the training of technicians in this important branch of chemical work.

In our view, the results obtained so far entirely justify the passing of the Act. The British dye industry to-day produces by weight 93 per cent., and by money value 72 per cent. of the dyestuffs consumed in this country. Before the war the industry was practically negligible, but there are now several millions of pounds of capital invested in the industry, which employs many thousands of people.

We think the period has been too short to enable us to catch up the long start our competitors have had, but we feel certain that within a given time we shall arrive, at any rate, at an equality, if we do not surpass them. Time is of the utmost importance.

Continental makers—the Germans, Swiss and French—are to-day practically working in the form of a mutual cartel. Not unnaturally we have been asked from time to time to become partners in such an organisation, but we have refused to do so on the terms which have been proposed to us, which, though possibly financially attractive, would have involved the crippling of the industry, the cessation of its future development, and the reduction of the number of people employed in it. We have felt it was our duty to bring this industry into such a state that it would not be subservient but equal to the condition of the industry in any other country.

*From Lord Melchett's address at the annual meeting of Imperial Chemical Industries, Ltd., on April 29, 1930.

Dyestuffs Licences for April

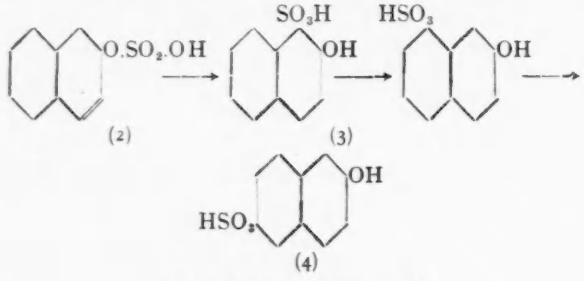
THE following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during April, has been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee :—

The total number of applications received during the month was 688, of which 588 were from merchants or importers. To these should be added 11 cases outstanding on March 31, making a total for the month of 699. These were dealt with as follows :—Granted, 651 (of which 633 were dealt with within 7 days of receipt) ; referred to British makers of similar products, 33 (of which 28 were dealt with within 7 days of receipt) ; outstanding on April 30, 15. Of the total of 699 applications received, 661 or 95 per cent. were dealt with within 7 days of receipt.

Basic Intermediates for Dyestuffs: No. XXXIV.—The Naphthol Sulphonic Acids.—(2)

By "Consultant"

In part XXXIII of this series the manufacture of Schaeffer acid by the monosulphonation of β-naphthol was described. It is, perhaps, the most widely used of the naphthol monosulphonic acids, but it is only after several "rearrangements" have taken place that the 6-sulphonic acid is formed. β-Naphthol is readily attacked by sulphuric acid at ordinary temperatures with the formation of the β-naphthyl sulphuric ester (2), and the various monosulphonic acids are formed by the migration of the $-SO_3H$ group from the ester group to the nucleus. The first migration occurs when the ester is heated in sulphuric acid solution, and the sulphonic group enters the "1" position, giving 2-naphthol-1-sulphonic acid. This substance is of commercial importance and its preparation is described below. On heating the 1-sulphonic acid (3), the sulphonic acid wanders into the "8" position, giving the Crocein acid (2-naphthol-8-sulphonic acid), which on further heating is transformed to Schaeffer acid, by the further migration of the sulphonic group to the "6" position (4). It may be added that this transformation is never quite complete and there is always formed an equilibrium mixture of the two acids; the higher the temperature to which the mixture is heated, the larger is the amount of the 6-acid formed.



(2) (3) (4)

2-Naphthol-1-Sulphonic Acid

When β-naphthol is sulphonated for the preparation of this compound the essential factor is the temperature, which must be kept down below 40°C. in order that the migration to the "8" position, referred to above, shall not take place. The original process of Tobias is used; at the present time, with little or no modification. The sulphuric acid is prepared by adding water (1 gal.) to the 98 per cent. acid of commerce (1 cwt.); when cool, β-naphthol (50 lb.) is sifted in and the temperature allowed to rise to 40°C., at which point it is allowed to remain for about a quarter of an hour, when the mass solidifies. After dilution with water the sodium salt can be salted out in the usual way, but is contaminated with quite appreciable quantities of the 6- and 8- sulphonic acids. In many cases this is not a very undesirable feature, but in cases where a pure acid is required sulphonation is effected by means of chlorsulphonic acid in carbon disulphide solution. This gives, exclusively, substitution in the "1" position. The sulphonic acid is recovered by the removal of the solvent, only the theoretical quantity of chlorsulphonic acid being needed.

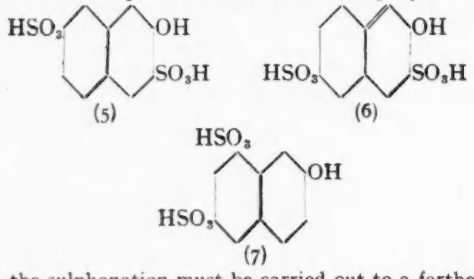
The use of 2-naphthol-1-sulphonic acid for the production of Tobias acid (2-naphthylamine-1-sulphonic acid) is the main purpose for which this particular acid is designed, and by means of the Bücherer reaction (the action of ammonium sulphite and ammonia) on the naphthol sulphonic acid a good yield of Tobias acid may be obtained. The details of this process have been described in a previous contribution. One feature of 2-naphthol-1-sulphonic acid which is well worthy of notice is the readiness with which it is hydrolysed, even on boiling in aqueous solution, back to β-naphthol. Chemically, it often reacts as β-naphthol would, the sulphonic acid group being removed during the reaction. This has led to a proposal to use 2-naphthol-1-sulphonic acid as an end component in the production of diazo colours, in place of β-naphthol. It has the advantage of being easily soluble in water, and gives the same dye as that from β-naphthol, since on adding the diazo solution the 1-sulphonic group is removed.

β-Naphthol Disulphonic Acids

The preparation of 2-naphthol-3 : 6-disulphonic acid is, as a rule, combined with the manufacture of Schaeffer acid, since by this means the formation of Crocein acid (2-naphthol-8-sulphonic acid) in any appreciable amount is eliminated. Sufficient oleum (20 per cent.) is added (1 gal.) to the commercial 98 per cent. acid (100 gal.) and the β-naphthol (140 lb.) is stirred in after having been very finely powdered. The temperature rises to 80° C., and stirring is maintained until all signs of the β-naphthol have disappeared, after which the temperature is raised to 105° C. and kept there until a test sample shows no precipitated solid on pouring into water. Between three and four hours' heating is usually necessary before this point is reached. The isolation of the acid is accomplished by diluting the sulphuric solution with water (500 gal.) and neutralising with lime. The conversion of the calcium salt to the sodium salt is effected without any filtration, sodium sulphate solution being added until a filtered test gives no calcium sulphate on addition of a further quantity of sodium sulphate. At this point the filtration is carried out, the press cake being thoroughly washed with warm water. The whole batch is evaporated down to 270 gallons and salt (½ cwt.) added. During the subsequent twenty-four hours, cooling and stirring being maintained, the Schaeffer acid separated as the sodium salt. About 160 lb. of Schaeffer salt (calculated as 100 per cent.) are obtained, and about half this quantity of the acid-R salt is obtained by acidification of the filtrate from the Schaeffer salt, with concentrated sulphuric acid.

The acid sodium salt of R-acid forms tiny needles, but the acid itself is a deliquescent, rather unmanageable substance. R-acid is used either for the preparation of the corresponding amino acid 2-naphthylamine-3 : 6-disulphonic acid (Amido-R-acid) which is in limited demand (6), or as an end-component in azo dye manufacture. It usually gives red shades on coupling.

The method described gives only a comparatively poor yield of R-salt, the bulk of the naphthol being transformed into the mono-sulphonic acid. Where a larger yield is necessary, the sulphonation must be carried out to a farther stage. This, however, entails the formation of a certain amount of G-acid (2-naphthol-6 : 8-disulphonic acid).



(5) (6) (7)

The manufacturing processes for the preparation of R-acid (5) and G-acid (7) are an interesting example of the way in which demand affects the methods of production. In the early days of the naphthol disulphonic acids the R-acid was highly esteemed on account of the fact that it produced redder shades than G-acid, which produces yellow shades (hence, R = *rot*, G = *gelb.*). This led to the relegation of G-acid to the position of an almost unwanted by-product. The position is now almost reversed; the growing importance of G-acid for the production of Gamma acid, Phenyl gamma acid and such dyes as Wool Green S, has led to the adoption of manufacturing processes which have as their object the production of a maximum yield of G-acid.

In the original process the naphthol was sulphonated at 105° C. with sufficient sulphuric acid to convert the whole of it into disulphonic acids, and the method suggested for the separation of the two isomers was extraction with 80 per cent. alcohol; an expensive and technically unsuitable

method, since the separation is not complete. The present processes, of which two are current, depend, in part, on the comparatively insoluble nature of the acid potassium salts of G-acid. In the first of these processes the finely powdered β-naphthol is added (140 lb.) to a mixture of 98 per cent. sulphuric acid (200 gal.) which has been brought to 100 per cent. strength by the addition of 20 per cent. oleum (2 gal.). The temperature is kept quite low—30-35° C.—until sulphonation, which is assisted by vigorous stirring, is complete. This should be complete after about 50 hours, and if the test sample shows a precipitate of free β-naphthol on solution with water, a little oleum is added to complete the reaction. The best yields are obtained from batches in which this procedure is unnecessary. The decomposition is effected by lime (after dilution with water (500 gal.), followed by commercial 90 per cent. potassium sulphate. Filtration gives a clear solution containing the acid potassium salt. The solution is evaporated to 220 gallons and acidified with strong hydrochloric acid (Acid to Congo). On cooling, the acid potassium salt of G-acid separates and after standing till the next day may be filtered off and washed with a solution of potassium chloride (1 lb. per gal.). The mother liquor contains the R-acid, and this is often used direct, or salted out where the solid acid is required. For the quantities mentioned above 150 lb. of salt would be needed.

In the second, or American process the naphthol (1 cwt.) is sulphonated at a higher temperature (60°C.) with 98 per cent. sulphuric acid. After sulphonation has been completed (2-3 days) the melt is run out, water (250 gal.) and potassium sulphate added (135 lb.). The solution is neutralised at the boil with milk of lime and evaporated until crystals commence to separate on the surface, at which point the batch is filtered to remove deposited gypsum and allowed to cool. The G-salt (dipotassium salt) separated out, is filtered off, washed with potassium sulphate solution and stoved.

The filtrate which contained the dipotassium salt of the R-acid is boiled with lime (17 lb.). A basic calcium potassium salt of the R-acid separates out and is filtered off, washed, and suspended in water (35 gal.). The theoretical amount of sulphuric acid will now precipitate the calcium as sulphate, and from the filtrate the R-acid may be obtained by salting out with sodium chloride.

Dyes and Their Application: Recent Technical Progress

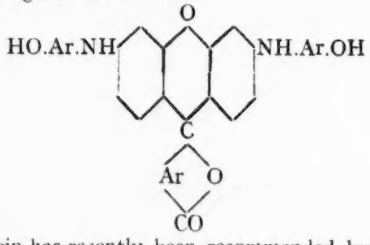
By L. J. Hooley

Basic Dyes

ALTHOUGH, except in one or two directions, research on the basic dyestuffs is of rather a restricted nature there are so many classes of basic colours that in the aggregate an appreciable amount of new work is still appearing. Being spread over a large number of sub-classes, it covers many points of widely differing interest, and the most important of these which have appeared during the last year or so will be given below.

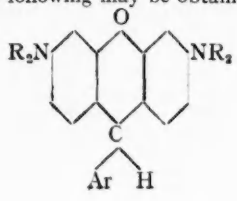
Xanthene Derivatives

The xanthene dyes, which include the important Rhodamines and Phthaleins, provide some of the most attractive colours of the basic series. Some new basic and acid dyes of Rhodamine type are prepared by Imperial Chemical Industries and L. J. Allchin (B.P. 303,243) by condensing fluorescein dihalides with unsulphonated amino phenols. The products are basic dyes which on sulphonation give valuable new colours having good solubility and excellent fastness to milling, stoving, acids and light. From *p*-amino phenol the body resulting has the formula



Fluorescein has recently been recommended by Fajans for the estimation of halogens. In the titration, any excess of silver solution gives the salver salt of fluorescein, which is then adsorbed by the precipitated silver halide, which thus changes in colour, so that the name "adsorption indicator" has been proposed. It has now been shown that dichlor fluorescein is more suitable than fluorescein itself (I. M. Kolthoff, W. M. Lauer and C. J. Sunde. *J.A.C.S.* **51**, 1929. 3273.)

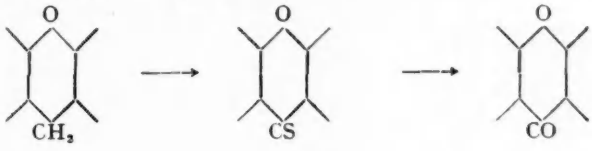
The method previously described in the B.P. 272,321 for making triaryl carbinols by treating aromatic halogen compounds such as chlorbenzene with the sodium compounds of 4·4¹ tetra-alkyldiaminobenzophenone has been extended to the xanthene series. By this means compounds of constitution similar to the following may be obtained :—



With the old benzaldehyde method of synthesis only a few colours of this type (Rosamines) have hitherto been synthesised, but as this method only requires a halogen derivative instead of an aldeyhde it is of much wider scope.

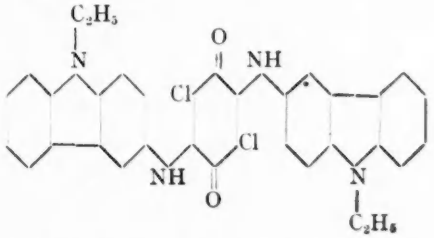
A variation on the above method (B.P. 320,345. I.C.I., A. Coulthard, E. H. Rodd) of more restricted applicability consists of using phosphoryl chloride or similar substance as condensing agent instead of sodium and a secondary or tertiary aromatic amine instead of a halogen derivative. The products obtained are much more highly basic than the known Rhodamines. From 3·7-tetramethyldiamino-xanthone, a bright magenta dye is obtained by heating with ethyl naphthylamine and phosphoryl chloride in toluene.

The first commercially practicable method for making N-substituted-3·7-diaminoxanthones has been described in B.P. 314,826 (I.C.I., E. H. Rodd, and H. H. Stocks). It has been found that the corresponding xanthene derivatives, which are already known, will combine quantitatively with sulphur to form the corresponding xanthiones, and these may be converted to the xanthones by known methods, for example, by warming with acid.



Oxazines

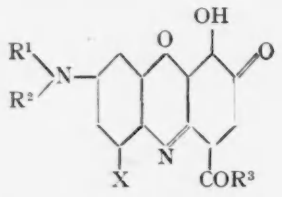
Diarylidobenzoquinone derivatives may be converted to oxazines by heating either alone or in the presence of high boiling solvents. The resulting products may then be sulphonated if desired. As an example 2·5-di (N-ethyl-carbazaloyl-3¹-amino)-3·6-dichlor-1·4-benzoquinone gives a blue (B.P. 313,094. I.G.F.A.-G.).



The sulphonated products are used in B.P. 314,068 (I.G. F.A.-G.) for colouring paper web or pulp.

Gallocyanines

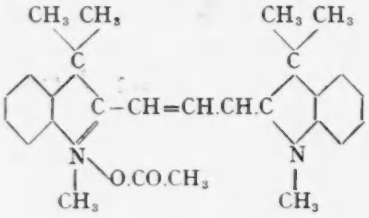
Increased stabilty in discharge printing is obtained with gallocyanines by converting bodies of the constitution



where X is a hydroxy or halogen group, into derivatives in the usual manner; the corresponding bodies without X are less stable to hydrosulphite (B.P. 301,329, Durand and Huguenin).

Poly Methine Dyes

Quinoline dyes of Pinacyanole type are described in B.P. 321,155 (I.G.F.A.-G.). Condensation products are first formed from formaldehyde and cycloammonium derivatives, such as 1·3·3-trimethyl-2-methylene indolin, and these then treated with an oxidising agent in a non-alkaline medium.



Miscellaneous Basic Dyes

Five new isomers of dehydrothio-p-toluidine having their methyl and amino groups in other positions have been prepared by M. T. Bogert, R. W. Allen (*J.A.C.S.* **49**, 1927, 1315). From these new bases new Thioflavines have been obtained, and also a new Chloramine yellow.

Basic dyes are obtained by condensing naphthostyril with tertiary aromatic amines or phenols using acid condensing agents such a phosphorus chloride. They are stated to be faster to light than the triphenylmethane dyes. On sulphonation, acid dyes are obtained.

Acridine Derivatives

The alkylation of hydroxy acridines is described in B.P. 317,619 (I.G.F.A.-G.). For example, 3·6-dihydroxy acridine is dissolved in water with two molecules of acid absorber, and treated with methyl p-toluene sulphonate. The 3·6-dimethoxy-10-methyl acridinium chloride is formed.

Amino acridines can be converted to ω-sulphonic acids by treatment with aldehyde bisulphites. They have antiseptic properties and are stated to have low toxicity (B.P. 293,617, A. G. Green).

Mordants for Basic Dyes

W. Eberlein and the Colloisil Colour Co. recommend the use of colloidal suspensions of natural or artificial silicates. These can be applied either before or along with the dyestuff, being subsequently fixed by heating or treating with an electrolyte (B.P. 247,328). Arylamides of beta-oxy naphthoic acid can also be used as mordants for basic colours (they are claimed to have the advantages over the usual treatment of providing better exhaustion and deeper shades than with tannin and elimination of the after-treatment necessary with tartar emetic (G.P. 441,326, I.G.F.A.-G.).

Basic mordants are also claimed to be obtained by the action of condensing and sulphonating agents on bodies of a fatty or resinous character, for example, the distillation products from petroleum or brown coal tar (B.P. 304,608. Oranienburger C.F.A.-G.).

Basic dyes may be combined with bodies of mordant like character before dyeing, for example, methylene blue is condensed in the form of its free base with aromatic hydroxy acids, for example, salicylic acid, beta-resorcylic acid or tannin in the presence of a mineral acid. These products can then be fixed on the fibre without steaming (E. I. Du Pont, F.P. 620,746, U.S.P. 1,659,145).

As regards the mechanism of the mordanting of basic dyes, A. Guenther does not agree with Victorov that digallic acid and natural tannin behave in the same way in mordanting, one of his reasons being based on the fact that a digallic acid prepared by E. Fischer's method does not mordant cotton with tartar emetic.

Dyestuffs Markets: The Month's Business in Review

From Our Own Correspondents

Lancashire

THE additional publicity which is being given to fabrics of cotton, and cotton and rayon unions, by Cotton Week, and special advertising campaigns, will have at least the effect of causing more people to appreciate the great beauty, and, in many cases, remarkable wearing properties of modern textile fabrics of these materials. How far it will help in solving the difficulties of the Lancashire cotton industry is more problematical!

It is pleasing to record that dyestuff sales have been appreciably better during the last two or three weeks, and there is once again the optimistic feeling abroad that the worst has been seen. One consequence of bad trade is frequently a more energetic effort to improve the quality and to produce more originality in styles, and there is ample evidence at present of activity in these directions.

Relatively to other dyestuffs, vat dyes still continue their advance. The standard of dyeing of mixed fabrics of cotton and rayons is being steadily raised, by, for example, the application of the solubilised vat dyes, such as the Soledon Colours, more especially for light shades.

The Icyl range of dyestuffs, capable of producing reasonably level shades on normally uneven-dyeing viscose, has been extended, and a new range is promised by the Society of Chemical Industry (Basle), named the "Rigan." Very good results are being obtained in the production of solid shades on viscose and cotton cloths by the use of some of the diazotised and developed dyestuffs, sometimes applied simply as direct dyestuffs, and in other cases actually developed.

Another common effect of slack trade is being experienced, namely, the tendency on the part of the wholesaler and retailer to demand a higher standard of fastness and qualities generally. At the present time reports from several different branches of the printing industry indicate that considerable attention is being given to fastness to rubbing, and that in some cases a guarantee is being demanded. There is a danger that pressure of this kind may be applied too heavily. In the present state of the art, it is not possible for textile fabrics of all kinds to be printed in the ranges of brilliance demanded to-day and, at the same time, to secure a degree of fastness to rubbing, especially against damp white materials, such as could reasonably be guaranteed.

Scotland

The best that can be said about last month's business is that it has been much the same as the previous one. With the general tendency of the last few months being in the direction of the down-grade, this result, although not altogether satisfactory, is not without its value. As far as Scotland is concerned, the dyeing and finishing trades are not worse than trades generally, and the usual view seems to be that, after hoping for three or four years for the return of prosperity, expectations for the moment must be on a lower plane, and that there may be cause for satisfaction in conditions getting no worse. Unfortunately, at the moment, world conditions are not pointing to any immediate improvement.

Orders in the tweed trade are rather scarce, only a few mill-owners being able to keep all their looms running. Tweed manufacturers are now showing their new ranges for the spring season, but so far these are not going off very rapidly. Dyers generally are affected by the textile conditions, but sales of dyestuffs do not show any great change. The dyestuff factory at Grangemouth continues to expand, and the steel structure is rising for another chemical house.

Dyestuffs Monthly Supplement

Published in the second issue of "The Chemical Age" each month

Communications relating to editorial matter for the Dyestuffs Monthly Supplement should be addressed to the Editor, THE CHEMICAL AGE, Bouverie House, 154, Fleet Street, London, E.C.4. Advertisement matter, subscriptions, etc., should be sent to the Manager. The Supplement is devoted to the interests of both manufacturers and users of dyestuffs, and contributions will be welcomed.

For Exceptional Services

The presentation of the Gold Medal of the Society of Dyers and Colourists to Mr. Arthur Silverwood, the honorary secretary from 1913 to 1930, fittingly recognises services of great value to the Society. During his seventeen years of office Mr. Silverwood had not missed a single meeting of the council, and one of the principal reasons of his retirement is his removal from Bradford to Manchester. The Gold Medal of the Society is not frequently given; to Mr. Silverwood it is 'awarded for exceptional services to the Society from 1913 to 1930." Mr. Silverwood has no intention to sever his connection with the Society, and hopes to find work for it in other directions. Among the pleasantest memories of office is the number of distinguished people with whom it has brought him into contact. Two he particularly mentioned were Ivan Petraczek and Edmund Knecht.

Dyestuffs Licences for May

The following statement relating to applications for licences under the Dyestuffs (Import Regulation) Act, 1920, made during May, have been furnished to the Board of Trade by the Dyestuffs Advisory Licensing Committee:—

The total number of applications received during the month was 720, of which 641 were from merchants or importers. To these should be added 15 cases outstanding on April 30, 1930, making a total for the month of 735. These were dealt with as follows:—Granted, 713 (of which 671 were dealt with within seven days of receipt); referred to British makers of similar products, 14 (of which 10 were dealt with within seven days of receipt); outstanding on May 31, 8. Of the total of 735 applications received, 681, or 93 per cent., were dealt with within seven days of receipt.

American Colour Chemist's Visit

Dr. Chas. E. Mullin, head of the Division of Textile Chemistry and Dyeing in the Clemson College (S.C.) Textile School, is sailing for Europe this month. He will continue his study of the textile schools and textile education abroad.

During several years past Professor Mullin has visited a very large number of the European rayon, silk, cotton, wool and dyestuffs plants, and has taken many new foreign processes to America. All of these now form a part of the textile course at Clemson College. He will continue these studies on the present trip, and also hopes to add many new and unusual textile materials to his present collection.

Sophora Japonica

In the *Science Quarterly* of the National University of Peking, Mr. Wu-Yu Marr, B.Sc. (Colour Chemistry, Leeds), formerly research chemist with "Usines des Couleur d'aniline," Brussels, has some interesting notes, in an account of the natural dyestuffs produced in China, on the flower or beans of Sophora Japonica, a plant that grows abundantly throughout China. The writer has been engaged for some years in the study of natural dyestuffs with a view to their larger utilisation. The dyestuff contained in the flower or beans of Sophora Japonica is a yellow colouring matter. With the aid of various mordants it gives a yellow shade of varying tone, chrome and tin giving a pure and bright yellow, alum and blue-stone a dull shade, and iron salts a brown colour. The dyeings so obtained are fast to soap and light and most of the common reagents. With chrome mordant this dyestuff gives a pure yellow suitable for fancy materials; the paler yellow from copper or aluminium mordant serves well for uniform goods; the brown given by iron is very fast to light, but rather loose to washing. With proper means the dyestuff can be applied to wool and silk as well as to cotton.

From his dyeing experiments, the writer concludes that this colouring matter could be extensively used in China, where the light-fastness determines the quality of a dyestuff above anything else. It is also recommended for dyeing silk (tin-weighted) a clean and bright yellow, a delicate shade which is useful in the silk trade. It can also be used for cotton dyeing by means of the same mordants as used for wool. The dyeings are, however, not so fast as on wool, and the processes of mordanting cotton are much more laborious. But for second class cotton goods, which do not require special fastness, the colouring matter is useful. The brown obtained with the aid of iron mordant is applicable for those classes of goods which do not require heavy washing.

German Dyestuff Trust's Affairs

At the general meeting of the I.G. Farbenindustrie this month at Frankfurt the proposals of the directors were accepted, including a 12 per cent. dividend plus a 2 per cent. bonus out of the first instalment of the concern's property released by the United States. According to an announcement by the directors, the financial position of the trust has undergone a favourable development in the course of the last few months. Its credit balances with banks, which stood at 136,000,000 marks, have been increased by a further 100,000,000 marks since the beginning of the year. The trust has hardly any bank debts at present. In the course of the general discussions, Dr. Bosch gave an explanation of developments during last year. On account of the great diversity in the concern's business, with its vast number of different products, fluctuations in the sales of various sections were unavoidable. Curtailments in one section were compensated by increased production in another. Such fluctuations could not fail to affect the number of employees in the different works. In all cases the directors were endeavouring to avoid social hardship. In reply to a demand for greater publicity in the profit account and more information about the present business situation in artificial silk and nitrogen, as well as about the agreements with the Standard Oil group, the directors repeated their statement of former years that they could not disclose more to competitors and that publicity was not greater in England, and especially in America, than it was in Germany. For the same reason, in the interest of the company no further information could be given concerning the relations with the Standard Oil group, which were progressing favourably.

Bleachers' Final Dividend

The reduction in the interim dividend of the Bleachers' Association from 6d. to 4d. per share had prepared shareholders for a less favourable statement for the year to March 31 last. For that period net profits, it is announced, amounted to £466,391, against £600,108 for 1928-29, a decline of 22·3 per cent. Apart from 1926-27, a year which covered the prolonged deadlock in the coalmining industry, this is by far the lowest profit recorded of recent years. The final dividend is reduced from 1s. 6d. to 1s. per share, making the dividend for the whole year 6⅔ per cent., compared with 10 per cent. for 1928-29. The appropriation to the general reserve is £59,187, against £100,000, while the balance carried forward is slightly smaller at £279,414. An allocation of £19,413 to the superannuation fund had no counterpart a year ago.

American Colour Fashions

From the Textile Colour Card Association of the United States we have received a number of reports showing the autumn fashion shades selected by various organisations representing branches of the textile and leather industries. These are intended to serve as advance guides both to manufacturers and retailers in the merchandising of costumes, etc., that have a definite colour scheme. The 21 colours chosen by the Associated Dress Industries of America are Brown and Beige (7), Red (4), Blue (4), Green (4), and Rust (2), together with an entire group of "Directoire" colours. The colours selected by the Allied Millinery Associations are :—Brown and Beige (6), Red (4), Rust (2), Blue (5), Green (3), Purple (1), and Grey (1). Ten colours are selected by the National Retail Dry Goods Association, namely, Brown (3), Red (2), Green (2), and Blue (2), and Copperglo. The importance of black was also emphasised. The colours considered of first importance are Manila Brown, Rubytone, Cricket Green, and Admiralty. Eight colours have been chosen for women's shoes and five for men's. A wide selection of colours has also been made for woollen goods and knitted outwear. It is stated that the Association's work in guiding colour fashions in the various industries is now widely appreciated throughout the United States and that the demand for the colour cards it issues is steadily increasing in other countries.

Textile Laboratory Equipment

An American correspondent informs us that the textile chemistry, rayon, and dyeing laboratories at Clemson College Textile School have been recently remodelled and entirely renovated so as to make room for considerable new equipment which is being installed. Some of the new equipment includes a small size combination raw stock and package dyeing machine made by the Columbus Truck and Supply Co., a small Chattanooga cotton raw stock dyeing machine, rubber lined dyeing, bleaching and diazotising tanks manufactured by the American Hard Rubber Co., a Laundry-Ometer for testing the fastness of colours to washing, a Permutit water softening plant, a glass-cell pH determination equipment, considerable new colorimetric pH apparatus, new rayon manufacturing equipment, a small laboratory centrifuge suitable for small skeins, liquid chlorine bleaching apparatus, sulphur dioxide antichlorine equipment, Monel metal rayon dyeing tanks, and two new types of spray printing apparatus for textiles. Among other equipment now on order are included more large size Monel metal dye tubs, complete pressure kier cotton boiling apparatus of the latest type, temperature control apparatus, and more rayon manufacturing apparatus, etc. In selecting this apparatus, every effort has been made to secure the very best types of equipment possible to demonstrate the actual plant scale operations in the laboratory, with the idea of giving the student every opportunity to gain industrial experience.

New Cellulose Acetate Process

According to Dr. Arthur D. Little, the United States Industrial Chemical Co., a subsidiary of the United States Industrial Alcohol Co., announced as an addition to its numerous products, cellulose acetate made by a new process. Cellulose acetate is the material resulting from the action of acetate anhydride upon cellulose (usually in the form of cotton) and chemically it may be considered to be analagous to cellulose nitrate made by the action of nitric acid upon cellulose. In contrast to cellulose nitrate, however, the acetate is relatively non-inflammable and upon this property depends its growing use in safety-films, although acetate rayon, of which over 7 million lbs. were manufactured in the United States last year, still represents by far the largest outlet for cellulose acetate. The company's new process is characterised by the use of liquid sulphur dioxide under pressure as the medium in which the action of acetic anhydride upon the cellulose takes place. This latest step in the development of an organisation which began as a fermenter of molasses to alcohol, has placed the company in the position of making one of the basic materials used in rayon, safety-films, and to a lesser degree in moulded articles, lacquers and other products. No announcement has been made by the company as to the particular fields in which they expect their new product to find application.

New Bleaching Process

Two German chemists, Gustav Adolph and Albert Pietzsch, have taken out U.S. Patent 1,750,657, of March 18, for a new bleaching process which they describe as follows : Hitherto, active oxygen has been used for bleaching chiefly in the form of hydrogen peroxide-solutions, except with soaps and oils that are bleached by means of persulphate or benzoyl peroxide. Bleaching by perborate or similar agents is practically a hydrogen peroxide bleaching process, since these chemical compositions split off hydrogen peroxide when dissolved. It was found that a number of articles can be bleached to advantage by mixtures of hydrogen peroxide and per-compounds, that do not split off hydrogen peroxide in the presence of water, as *e.g.*, persulphates or benzoyl peroxide. It might have been expected that such mixtures would decompose each other in a bleaching process, but such is not the case, rather a stronger bleaching effect taking place than with the employment of the single components. To obtain a more or less strong bleaching effect indifferent liquids, *e.g.*, alcohol, may be added to the bleaching solutions. The bleaching baths, according to the requirements, may be either alkaline or neutral or acid. If per-salts are used in an acid solution, the same bleaching effect results as with the addition of hydrogen peroxide, since hydrogen peroxide is split off from the per-compounds by the acid, so that this case forms a special case of the general process only. The bleaching effect of such mixtures is so strong, that they will bleach even in the cold, quickly and efficiently within a few hours.

From a Dyer's Window

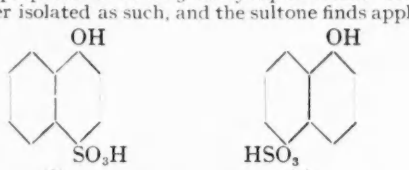
Mr. Jerome Alexander, a well-known New York chemist, while on a visit to England noted the following lines in a dyer's window, and reproduced them in the journal of the New York Chemists' Club :—

By dyeing I live,
And by living, I dye.
The more I dye, the better I live,
The longer I live, the better I dye.

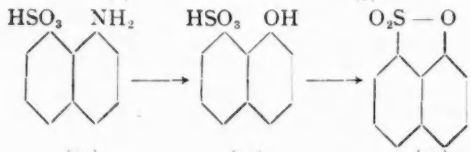
Basic Intermediates for Dyestuffs: No. XXXV.—The Naphthol Sulphonic Acids—(3)

By "Consultant"

In the list of naphthol sulphonic acids, set out in part XXXIII of this series, mention was made of various sulphonic acid derivatives of α-napthol, and it is the purpose of this article to complete the consideration of the naphthol sulphonic acids with an account of these derivatives. Among the mono-sulphonic acids there are only three that have attained any wide importance, namely, 1-naphthol-4-sulphonic acid (8) of NW (Neville and Winther) acid; the 1 : 8 acid which forms the sultone, and the 1 : 5 acid which forms an intermediate step in the preparation of 1 : 5-dioxynaphthalene. The 1 : 8-acid is never isolated as such, and the sultone finds application



(8) (9)



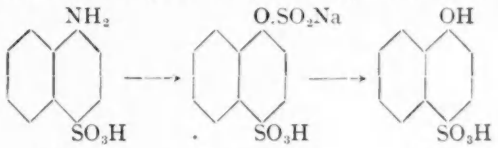
(10) (11) (12)

in the manufacture of the 1-naphthol-4 : 8-disulphonic acid (see below). The preparation of the sultone is carried out by the diazotisation of Peri acid (10) and by boiling the suspension of diazo compound until completely converted into the sultone (12). The 1 : 8 acid (11) is formed as an intermediate stage but can be isolated, if necessary.

In order to prepare the sultone in quantity, the Peri acid (100 lbs.) is dissolved in 5 per cent. sulphuric acid (2,500 galls.) by the use of direct steam. The solution is allowed to cool under stirring and no attention is paid to the separation of solid matter. When quite cold a solution of sodium nitrite in water (30 lbs. in 30 galls.) is run in with continued stirring at such a rate that no red fumes are observed at the top of the vat, due to loss of nitrite. When the diazotisation is complete the solution contains nearly the whole of the diazo compound in suspension. It is raised to 100° C. and gently boiled for some time by the use of direct steam, during which operation the sultone is formed by the loss of nitrogen and the elements of water from the diazo-Peri acid. The heating needs a little regulating towards the beginning when frothing, due to the evolution of nitrogen gas, takes place. The suspension may be filtered warm to facilitate the working of the press, since the sultone is almost insoluble in water. It needs no purification for use in the preparation of the 4 : 8 disulphonic acid (*q.v.*).

The 1-naphthol-4-acid (NW acid) is the most widely used of the monosulphonic acids of α-naphthol, and was prepared by the inventors by the diazotisation of naphthionic acid (13) in exactly the same way as that already described in connection with Peri-acid. This method (which has been given up in practice) had two serious drawbacks. In the first place, if strength of the sulphuric acid used in the boiling process on the diazo compound was increased above 5 per cent. there was a strong tendency towards the elimination of the sulphonic group hydrolytically, α-naphthol being produced, whilst, if the acid strength was maintained at 5 per cent., or below, coupling of the naphthol-sulphonic acid with the yet undecomposed diazo compound took place, decreasing the yield and colouring the product. For this reason the process has been discontinued, as also has the process of heating the sodium salt of naphthionic acid with caustic soda solution (50 per cent.) in an autoclave. This latter process gave a very poor yield, but was patented in Germany during the early days of dyestuffs intermediates. The later investigations of Fierz-David have shown that, in addition to the desired product, a large quantity of the corresponding dioxynaphthalene is produced at the same time, as might perhaps be expected. It is not possible to get much more than 50 per cent. of the theoretical yield of NW acid by this process.

Bucherer's reaction is the basis of the best method for the preparation of NW acid. It depends on the fact that when naphthionic acid (13) is heated with sodium acid sulphite NaH (SO_3), the hydrogen of the acid sulphite and the amino group of the sulphonic acid combine to give ammonia, leaving the intermediate sulphito compound (14) which on simple



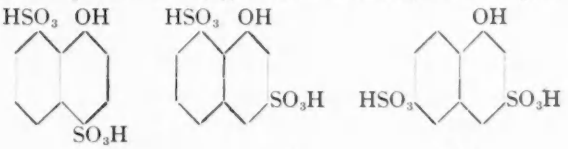
(13) (14) (15)

hydrolysis yields the desired NW acid. The process is comparatively simple to carry out. The naphthionic acid (½ cwt.) is placed in a low pressure autoclave together with water (3 galls.) and commercial 40 per cent. bisulphite liquor (66 lbs.) and heated at 115-120° C. for about ten hours. Some process men prefer to heat the reactants under a simple reflux cooler for 24 hours. The result is almost the same. After cooling, the liquid is made acid with hydrochloric acid and any unchanged raw material filtered off. There is a considerable amount of sulphur dioxide evolved during the neutralisation. The process for obtaining the NW acid depends on the fact that although the sulphito compound is not easily hydrolysed by acid, it is readily split up by alkali. The solution of the sulphito compound is therefore made alkaline with caustic soda and the solution boiled. The ammonia produced in the first part of the reaction is evolved during this operation, as also is the required NW acid, which can be set free from the cooled liquid by reacidification. The solution so obtained can be used straightway for coupling, since NW acid is used mainly as an end component in the production of azo-dyes (*e.g.*, direct cotton blues).

The 1 : 5 acid (1-naphthol-5-sulphonic acid) is only a passing phase in the manufacture of dioxynaphthalene. The naphthalene disulphonic acid is subjected to caustic fusion in an autoclave. By using a very short fusion it is possible to isolate the sodium salt of the 1-naphthol-5-sulphonic acid from the melt, but this is seldom done on account of the small demand for L-salt (the commercial name for sodium-1-naphthol-5-sulphonate.)

The Disulphonic Acids

As with the monosulphonic acids, there are only three of the disulphonic acids of α-naphthol which are of paramount importance; the 1-naphthol-4:8-disulphonic acid (16); the 3:8-disulphonic acid (17) known as ε-acid, and the 3:6-di-

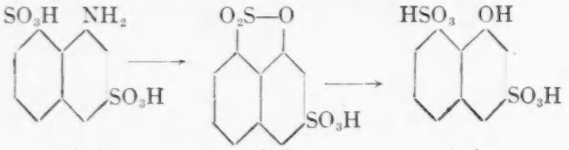


(16) (17) (18)

sulphonic acid (18). The first of these disulphonic acids, 1-naphthol-4 : 8-disulphonic acid is very easily prepared from the naphthasultone described above. This compound is heated with 98 per cent. sulphuric acid (two and a half times the weight of the sultone) at 85° C. Samples are withdrawn from the batch from time to time and poured into water. The sulphonation is complete when no precipitate of unchanged sultone is obtained on pouring into water. When this stage is arrived at, the whole batch is poured into water and the acid salted out in the usual way. There is little demand for this acid, which is used mainly in the preparation of dyes of the azo class.

ε-Acid

This acid is, perhaps, the most valuable of the disulphonic acids of the α-naphthol series, and is used for the production of all classes of azo dyes as an end component. It is obtained from the corresponding naphthylamine-disulphonic acid (19) by a process which is very much parallel to the process used



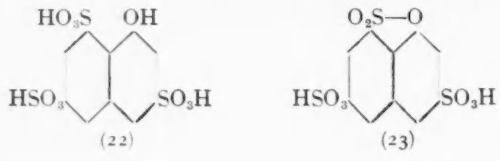
(19) (20) (21)

in the preparation of naphthasultone; indeed, a sultone is actually formed at one stage in this method of preparation. The naphthylamine-3:8-disulphonic acid (½ cwt.) is dissolved in dilute caustic soda solution (80 gallons; 1 per cent.), and the solution made acid by the addition of 18 lb. of 98 per cent. sulphuric acid. The solution of the acid is now ready for diazotisation, with a solution of sodium nitrite (12 lb.) in water. The diazo compound is not very soluble in water and separates as a mass of very minute white crystals. There is no need to separate the diazo compound, and in order to convert it to the sulphone derivative live steam is passed in and the liquid heated up to 100° C. until the evolution of nitrogen ceases. The naphthasultone sulphonic acid (20) separates in minute white crystals of the sodium derivative. This substance can also be obtained in the form of long needles. It contains three molecules of water of crystallisation, and is easily converted into the disulphonic acid by the action of caustic soda solution. It is also possible to use a direct process for the preparation of ε-acid from the diazo compound without the isolation of the sultonesulphonic acid. In this the diazo compound is filtered off and boiled with dilute sulphuric acid, the acid removed after boiling by liming, and the calcium salt of the ε-acid converted to the acid itself through the formation of the sodium salt in the usual way.

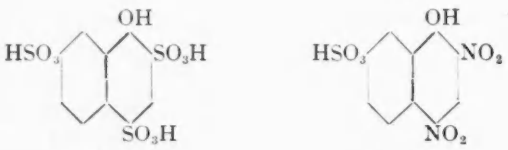
It may be added that the 1-naphthol-3:6-disulphonic acid is prepared in an entirely analogous way from Freund's acid, and is usually met with as the acid sodium salt, which, although very soluble in water, can be salted out. Like its isomers, it is used in the production of azo dyes.

The Trisulphonic Acids

Of the trisulphonic acids of α-naphthol, the 3:6:8 acid (22) is of major importance, the 2:4:7 acid having only a very limited application (24) in the production of Naphthol Yellow S (25), which is obtained from it by nitration, the 2- and 4-sulphonic groups being replaced by nitro groups.



(22) (23)



(24) (25)

The 1-naphthol-3:6:8-trisulphonic acid is prepared by a method which resembles in the extreme the methods already described for the production of members of this series, namely, by the decomposition of the diazo compound of the corresponding naphthylamine trisulphonic acid (Koch acid). In this case, as with the others in which there is a sulphonic group in the "8" position, a sultone is formed, which readily yields the corresponding acid by treatment with lime and sodium carbonate. The details are so similar to those already quoted that a minute description of the process is unnecessary.

Simultaneous Uniform Dyeing of Viscose and Cotton in Mixed Weaves†

ONE of the most difficult tasks involves not merely bringing the cotton to the same depth of dyeing as the viscose, but to the same tone. There is also a further complication, the possible streakiness of the dyed viscose. The dyer has to consider these points carefully before beginning work. While dyeing of the two fibres to the same depth of tone is generally possible for light tones, this is not usually the case with medium to deep tones; the greater affinity of the viscose for dyestuffs makes itself more or less strongly evident; the viscose is dyed more deeply than the cotton; a serious objection in the case of certain weaves, where the lightly dyed cotton back shows through the more deeply dyed viscose face.

Since the different dyestuffs behave differently in their relative affinity for viscose, it should be possible to classify them as has already been done in reference to the question of avoiding streakily dyed viscose alone. The Gesellschaft fuer Chemische Industrie, of Basle, has published a list of those dyestuffs which come into consideration particularly for this simultaneous dyeing, in uniform tone, of the cotton-viscose mixtures. The list is as follows:

(*a*) Direct Dyestuffs—Direct Yellow 5G Conc.*, Cotton Yellow CH*, Direct Fast Orange WS*, SE*, Direct Catechin GG*, B*, GR*, Cupranil Brown R*, B*, Direct Brown GN*, 5G*, Direct Fast Bordeaux G, Direct Fast Scarlet G*, B*, 3B*, SE*, R*, 10BS, Direct Scarlet 3BS, BS*, Direct Pink BN, 3BN, GN, Direct Safranine RW, Direct Brilliant Pink B, 3B, Chlorantine Lilac B, Direct Fast Violet 6BL, Melantherine BH, HW, GS, Cotton Blue N, Direct Brilliant Blue 6BR, 8B*, Direct Dark Green S, Artificial Silk Black GN, GE, Cotton Red 4B*, D*, Carbide Fulling Black PLS Conc.*, R Conc.*

(*b*) Chlorantine Light Dyestuffs—Direct Fast Yellow FF*, B*, Chlorantine Light Yellow 4GL*, RL*, Chlorantine Light Orange G*, TGL, TRL*, 2RL*, T3RL, Chlorantine Light Brown RL, 3RL, BRL, Chlorantine Light Red 5BL*, 7BL*, Chlorantine Light Rubine RL*, Chlorantine Light Violet RL*, BLN, 5BL*, 4BLN, Chlorantine Light Blue GLN, 4GL, 8GL*, BL, Chlorantine Light Gray BLN, GLN, RLN, BLL, RLL, Chlorantine Black L*.

By choosing suitable dyestuffs the problem is not entirely solved, for any choice excludes a number of other valuable products. However, with this grouping of the dyestuffs we have exhausted only one possibility. Another such lies in the modification of the fibres themselves, the viscose or the cotton, modification of their affinity for dyestuffs in such a way that compensation takes place. Such a modification can be attained, for example, through mercerisation, or by treatment of the mixed goods with caustic liquor of varying concentrations. But since viscose swells strongly in only reasonably strong caustic, the practical carrying out of this possibility is involved in considerable difficulty. There is a whole series of patents, in which procedures are described for protecting the viscose when mixed weaves are mercerised. Thus, for example, according to English patent No. 230,187, the viscose is treated, before weaving, with gelatine or gelatine aluminium acetate; according to English Patent No. 295,062, by washing of the fabric, after mercerisation, with water of from 70° to 100° C. damage to the viscose is obviated, while English Patent No. 295,488 recommends mercerisation with caustic potash. American Patents Nos. 1,343,138 and 1,344,139 recommend an addition of phenol or formaldehyde to the caustic soda, Patents Nos. 1,348,802 and 1,346,803 an addition of glycerol or monacetine. Finally, American Patent No. 1,392,833 prescribes saturation of the caustic soda

† Dr. A. Landolt; *Mell. Textil-Ber.* **10**, 214 (1929).

* These dye uniformly even in very deep tones.

liquor with potassium acetate. The treatment with caustic soda, however, apart from technical difficulties, involves certain disadvantages, the first of which is the rendering of the whole finishing process more expensive. Besides, effects result from the mercerisation which are not in all cases desirable.

A final possibility, that of modifying the affinity of viscose or cotton for the dyestuff, lies in the alteration of the conditions during the dyeing process. We know that when dyeing with direct cotton colours at a low temperature and with little salt, uniform dyeings are got more easily than at a higher temperature and with a higher percentage of salt. We dye best with addition of 5 to 10 per cent. of Glauber salt, bath 1–30, entering at 30° and going slowly to 50 to 60°. In this way, however, we attain deep dyeings only by use of large amounts of dyestuff. Now if the affinity of the mixed weave for dyestuff at the higher temperature be altered in favour of the viscose, it must follow that the viscose will have a greater affinity for the highly dispersed phase than the cotton, since even in dyestuff solutions an increase in the degree of dispersion goes hand in hand with a rise in temperature. If it were possible to decrease the degree of dispersion at the higher temperature, the affinity for dyestuff would be altered in favour of the cotton. This can be proved by experiment. If one increases the amount of salt in solution in the dye bath to an abnormal degree, that is, until the dyestuff is nearly salted out, many dyestuffs take more strongly upon the cotton than under normal conditions, while the viscose remains lighter in shade, so that compensation is possible in this way. We dye, for example, as follows: The dye bath is made up with 150 g. of Glauber salt cryst. per litre. At 40° C. the dyestuff is added in solution, the goods are entered, and dyed with gradual heating up to 80° C. The dye bath is almost completely exhausted, so that it can be used again by adding the proper amount of dyestuff. Whether this method of dyeing, which is theoretically very interesting, has also any practical value, is not yet certain. It has at least been proved that according to this method a simultaneous uniform dyeing of dark marine blue and brown tones, which up to now has been very difficult, is possible.

It should also be mentioned that the problem of this simultaneous dyeing could naturally be solved most fundamentally, if it were possible to produce a viscose with a lower affinity for dyestuffs. Cf. *Mell. Textil-Ber.* **9**, 684 (1928).

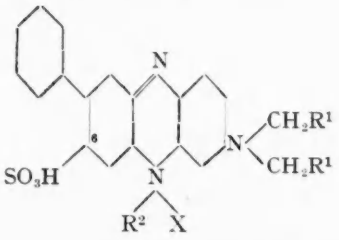
Dyes and Their Application: Recent Technical Progress

By L. J. Hooley

Azine Derivatives

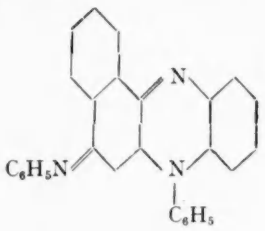
THE azine derivatives form one of the most important groups of the basic colours and are divisible into many subgroups.

Among recent products may be mentioned those of B.P. 300,549 (Geigy), where an unsymmetrical N-alkylated p-phenylene-diamine sulphonic acid having a sulphonic acid group ortho to the primary amine is condensed with an isorosinduline-6-sulphonic acid of the formula shown, the 6 group being removed in the process.

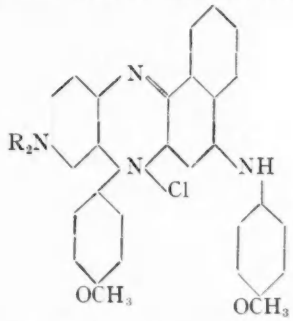


This patent is one of a series, the acid wool dyestuffs described in it being more violet than in the preceding ones. Included in these preceding ones is B.P. 297,341, which describes the production of acid fast dyes, by sulphonating phenylnaphthosafranine monosulphonic acids of similar general constitution to that shown immediately above.

The anilino naphthoquinoneanilides recently prepared by R. Lantz and A. Wahl have been found to act like anilino naphthoquinones in that the -OH- group is easily replaced, and on treatment with aniline, in the presence of a catalyst like phenol, phenyl rosinduline is formed (*Comptes Rendus*, 1926, 705).



Dyes of the Wool Fast Blue type, but faster to light, are obtained by using in place of the usual 1·3-diphenyl or ditolyl aminonaphthalenesulphonic acids, the corresponding alkoxyphenylamino bodies (B.P. 275,724, I.G.F.A.-G.).



Safranine dyes, giving blue to violet shades from an acid bath, are obtained by oxidation of a 4-acidylamino 3¹-amino or 4-nitro-3¹-amino diphenylamine sulphonic acid with a phenylene diamine (B.P. 300,178. I.G.F.A.-G.).

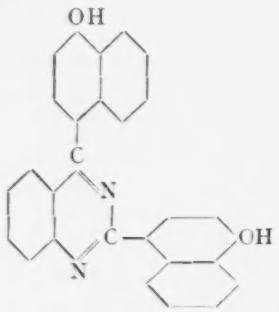
Dyestuffs suitable for copying inks may be obtained by coupling a diazo compound of a safranine with a β-diketone; diazotised tolusafranine with acetyl-acetone gives a claret red (B.P. 288,214, I.G.F.A.-G.).

Azine dyes are converted to products suitable for the level dyeing of regenerated cellulose by phosgenating acid wool dyes of the azine class, which have primary or secondary amino groups outside the azine ring system. These provide a contrast to the azo colours normally employed for this purpose (B.P. 296,803, B.D.C., and A. W. Sylvester). Oxazines have been converted to azines by submitting to a fairly strong treatment with a primary aromatic amine. Thus aniline with phenyl dinaphthazine gives phenylimino N-phenyl dinaphthazine (B.P. 285,840, S.A. Matières Colorantes).

Hydroxycarboxyphenazine-naphthophenazine or -dinaphthazine derivatives are obtained from the corresponding hydroxy derivatives with free positions ortho to the carboxy group by heating with carbon dioxide and an alkali. The products are useful intermediates for sulphur colours (B.P. 299,152, I.C.I., W. P. Pope, M. Wyler).

A wide range of quinazoline derivatives have recently been described. These although not normally basic dyestuffs may conveniently be considered here, as they belong to the benzodiazine series. In these patents, taken out by the I.G.F.A.-G. the first B.P. 287,179, describes the condensation of a 2- or 4- or a 2·4-halogenated quinazoline with a phenol or hydrocarbon using aluminium chloride in a solvent. α-Naphthol

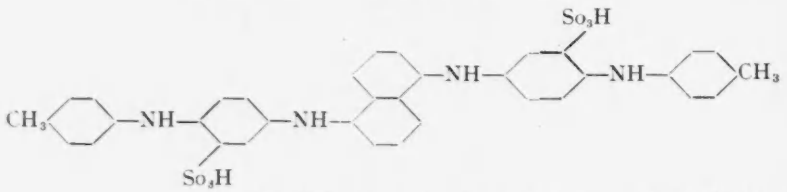
gives a body of the following constitution. This is an insoluble yellowish powder.



Further derivatives are described in B.P. 309,102, where a dihalogen quinazoline is condensed successively with one molecular proportion of each two compounds containing reactive hydrogens attached to nitrogen, oxygen or sulphur. The resulting products may be used in the synthesis of azo colours. In B.P. 310,076 mono-chlor quinazoline is used from condensing H with acid, for example.

Dyes of Aniline Black Type

Animal fibres can be dyed in black shades by impregnating rom an acid bath with sulphonated p-phenylenediamine derivatives or 1·4-di(4-aminophenylamino) benzene derivatives, and then treating with an oxidising agent, for example, a dichromate (B.P. 306,632, I.G.F.A.-G.).



Another similar method is that of B.P. 289,730 (I.G.F.A.-G.), 2-(3¹-amino-phenyl)amino naphthalene hydrochloride or similar derivative being dyed on to animal fibre, particularly leather, hair, etc., and then treated with sodium nitrite and acetic acid, a yellow to red shade being obtained. In B.P. 290,126 (I.G.F.A.-G.) 4¹-aminophenylaminonaphthalene and similar derivatives are employed, these also being oxidised. Examples are given of the production of green, blue and black shades. For dyeing animal fibres with aniline black, metallic catalysts may be added along with aniline salt, the oxidiser and a salt of an easily oxidisable acid which will protect the fibre (B.P. 294,554, K. Schmidt). Carbonyl ferrocyanides are recommended as oxygen carriers for aniline black and other processes requiring oxidation (B.P. 296,530, Manchester Oxide Co. and F. Scholefield).

Dyestuffs Markets: The Month's Business in Review

From Our Own Correspondents

Lancashire

In these notes a month ago it was suggested that there was some indication in the sales of dyestuffs of an improvement in the textile industry generally. Perhaps once again the wish was father to the thought; at any rate, the last month has seen no appreciable improvement in the dyeing and printing sections.

However, as frequently happens, a period of depression from the selling point of view is characterised by, or even determines, increased activity in the technical and research sections. Evidence of this in the dyestuff industry is to be seen on all sides, and specific instances have been mentioned here recently. Perhaps the most striking example, at least from the point of view of chemical constitution, is the new product—probably the first of a series—offered by Imperial Chemical Industries under the name "Solazol." In a most ingenious manner, the chemists of I.C.I. have produced a substance combining the properties of the Soledon and the "azoic" dyestuffs—that is to say, Solazol Red is an azoic dyestuff rendered soluble and capable of direct application to a wide variety of textile materials by the introduction of certain chemical groups, some of which also confer the property of easy oxidation to an insoluble and therefore fixed colouring matter.

The whole effect is that of taking an insoluble pigment of the Naphthol AS series, converting it into a soluble leuco body which is capable of ready conversion into the insoluble Naphthol AS or azoic pigment, although chemically this is not quite accurately described.

It remains to be seen how far this new idea in colour chemistry will find industrial application; but a ready means of dyeing unions of cotton and wool, or cotton and silk, in fast brilliant shades such as are characteristic of the "azoic" series, appears a useful addition to the dyer's already extensive technique.

Scotland

Business in Scotland during May, although not good, has remained fairly uniform and at the same general level as in April. This applies particularly to activities dependent on local conditions, which are fairly steady, as distinct from the downward tendency in world trade at the moment and disturbances due to Indian matters.

In and around the Glasgow district, dyers and finishers have found orders rather variable, but sufficient to maintain employment figures steady. Carpet manufacturers are moderately busy. In the south, the Scotch tweed manufacturers are still not in a position to keep all their looms working, although the next season's orders are coming in a little faster. Low priced and inferior cloths, of course, provide one of the principal causes of competition. In the markets where the excellent qualities of the Scottish tweeds are recognised they continue to hold their own for better class custom, and maintain their position in foreign markets, which are in fact responsible for much of the business. The allied hosiery sections remain fairly steady.

Sales of dyestuffs fluctuate slightly as between the various classes, and there is even at the present time an increase in the faster series. The total sales, however, keep fairly constant when averaged over two or three months at a time. A satisfactory feature is an increase in exports, both to Europe and to the East. Still further extensions may be noticed in the dyestuff factory at Grangemouth.

Italian Dye Corporation

In spite of an increase of 18 per cent. in the sales of the A.C.N.A. (Italian Dye Corporation), as compared to last year, and net profits of 8,232,362 lire, on which the company has declared a dividend of 9 per cent. (as compared with 6 per cent.) commercially and financially, states the annual report for 1929, the year was a difficult one. The A.C.N.A. was not able to carry out the increase in capitalisation proposed last year, and the resources of the company were heavily drained for the purchase of the Bussi plant, the amortisation of liabilities connected with the absorbing of the older companies, the purchase of heavy stocks of raw and semi-raw materials and the expenses connected with setting up a marketing organisation.

Industrially, considerable progress was made. An important plant was completed at Bussi for the production of trieline, and among the new products put on the market were metallic sodium, peroxide, a series of new vat dyes for wool and cotton, and naphthol intermediates.

Metallurgical Section

Published in the first issue of "The Chemical Age" each month

RUST DEFEATED

TO the Industrialist of to-day RUST is the real "Red Peril." It has its ever working "cells" deep down in the vitals of your chemical plant or equipment. It strikes at the very heart of efficiency. Its slogan is "Destruction." Its organisation is directed against the whole established community of metals.

There exists, happily, one sure antidote for this "red poison"—a strong, constructive, corrosion-resisting champion of progress and enlightenment—

FIRTH STAYBRITE

The Acid and Chemical-resisting Steel.

May we send you our Booklet 231 on Firth Stainless Steels?

The photograph shows a group of Chemical Valves made from Firth Staybrite Steel.

THOS. FIRTH & SONS LTD.
SHEFFIELD

WHATEVER YOUR BUSINESS

you will find something of interest in

Benn's Sixpenny Library

Complete reference library to the best modern thought at a price within the reach of everyone. Each volume in this world-famous orange-covered series is a full-length book by a leading authority. Each is printed in clear type on opaque paper, eighty pages of admirable reading. "They are about as good as anything of similar scope could be."—*Arnold Bennett.* "Admirably written."—*Hugh Walpole.* "Sound sense for your sixpence."—*The Daily Herald.*

OVER 130 TITLES

Art

23 ENGLISH WATER-COLOUR PAINTERS. C. E. Hughes.
32 ENGLISH STAGE. Allardyce Nicoll.
39 ELIZABETHAN DRAMATISTS. C. J. Sisson.
67 ARCHITECTURE. Christian Barman.
69 HISTORY OF MUSIC. P. C. Buck.
80 THE ENGLISH HOUSE. A. R. Powys.
92 ROME. Thomas Ashby.
227 THEORY OF MUSIC. Greville Cooke.
230 ENGLISH FURNITURE. Oliver Brackett.
231 ENGLISH DRAMA. H. F. Rubinstein.

Biography

43 DANTE. C. Foligno.
81 NAPOLEON. J. Holland Rose.
140 SIR ISAAC NEWTON. V. E. Pullin.
165 CHRIST. R. J. Campbell.
251 NELSON. Sir George Aston.
252 OLIVER CROMWELL. Hilaire Belloc.

History

1 ENGLAND. D. C. Somervell.
2 WORLD OF GREECE AND ROME. E. Bevan.
40 PRE-ROMAN BRITAIN. H. J. Massingham.
4 ROMAN BRITAIN. Gordon Home.
8 EUROPE. R. B. Mowat.
9 HOLY ROMAN EMPIRE. E. F. Jacob.
11 GERMANY. W. H. Dawson.
12 RUSSIA. Prince Mirsky.
13 ITALY. Mrs. G. M. Trevelyan.
86 BRITISH EMPIRE. Douglas Woodruff.
14 UNITED STATES. Robert McElroy
15 CHINA. W. E. Soothill.
44 JAPAN. J. Ingram Bryan.
16 THE PAPACY. A. L. Maycock.
17 ANCIENT EGYPT. Arthur Weigall.
18 INDIA. Edward Thompson.
25 WAR ON LAND, 1914-18. Douglas Jerrold.
88 WAR ON SEA. Stephen King-Hall.
79 LEAGUE OF NATIONS. Wilson Harris.
19 ISLAM. Sir Denison Ross.
20 THE REFORMATION. David Ogg.
26 BRITISH PRIME MINISTERS (1700-1890). F. J. Hearnshaw.
34 ATHENS. E. H. Warmington.
38 WESTERN EUROPE, 1-455. M. Cary.
74 WESTERN EUROPE, 455-1453. Claude Jenkins.
61 WESTERN EUROPE, 1453-1789. Sir C. Grant Robertson.
89 THE FRENCH REVOLUTION. Alison Phillips.
50 EUROPE IN THE AGE OF NAPOLEON. R. B. Mowat.

History—*contd.*

46 THE BLACK DEATH. G. G. Coulton.
10 WESTERN EUROPE, 1815-1926. D. C. Somervell.
60 LONDON. Gordon Home.
71 THE INQUISITION. G. G. Coulton
72 INDIAN STATES AND PRINCES. Sir Sidney Low.
73 IRELAND. Sir James O'Connor.
77 SCOTLAND. R. S. Rait.
78 FRANCE. Sisley Huddleston.

Law and Economics

21 THE PRESS. Sir Alfred Robbins.
22 RAILWAYS. Lord Monkswell.
27 CRIMINOLOGY. Horace Wyndham.
30 BRITISH CONSTITUTION. Sir Sidney Low.
41 LEGAL SYSTEM OF ENGLAND. J. E. G. de Montmorency.
48 ENGLISH ECONOMIC HISTORY. E. Levett.
82 SCOUTING. Sir Robert Baden-Powell.
85 DIPLOMACY. Sir Rennell Rodd.
93 PRINCIPLES OF LAW. J. E. G. de Montmorency.
161 DEVELOPMENT OF POLITICAL IDEAS. F. J. Hearnshaw.
170 EDUCATIONAL THEORIES. Sir John Adams.
171 ENGLISH EDUCATIONAL SYSTEM. Cyril Norwood.
177 TRADE. Sir Ernest Benn.
179 MONEY. Hartley Withers.

Literature

3 EASTERN ART AND LITERATURE. Sir Denison Ross.
28 THE FRENCH NOVEL. H. Ashton.
35 THE ENGLISH LANGUAGE. E. Weekley.
51 ENGLISH LITERATURE. C. H. Herford.
52 FRENCH LITERATURE. Maurice Baring.
53 ITALIAN LITERATURE. E. G. Gardner.
54 SHAKESPEARE. G. B. Harrison.
55 GERMAN LITERATURE. G. Waterhouse.
56 RUSSIAN LITERATURE. J. Lavrin.
59 MYTHS OF GREECE AND ROME. Jane Harrison.
87 THE ENGLISH NOVEL. J. B. Priestley.

Religion & Philosophy

24 GREAT PHILOSOPHIES OF THE WORLD. C. E. M. Joad.
29 THE FREE WILL PROBLEM. Wildon Carr.
33 ENGLISH FOLKLORE. A. R. Wright.
42 THE ISLAMIC FAITH. Sir Thomas Arnold.
47 EARLY CHRISTIANITY AND RIVALS. G. H. Box.
58 BUDDHISM. K. Saunders.

Religion, etc.—*contd.*

62 CHURCH AND STATE SINCE REFORMATION. N. Sykes.
83 LOGIC AND REASONING. S. V. Keeling.
94 PHILOSOPHY. J. L. Stocks.
123 RELIGIONS OF THE WORLD. C. C. Martindale.
144 RELIGION AND SCIENCE. Charles Singer.
162 PLATO AND ARISTOTLE. J. A. K. Thomson.
166 CATHOLICISM. M. C. D'Arcy.
167 PROTESTANTISM. Dean Inge.

Science

5 ORIGINS OF CIVILISATION. E. N. Fallaize.
6 ORIGINS OF AGRICULTURE. Harold Peake.
7 NUTRITION AND DIETETICS. E. P. Cathcart.
31 OCEANS AND RIVERS. E. G. R. Taylor.
36 ASTROPHYSICS. W. M. Smart.
37 SCIENCE AND REALITY. R. A. Sampson.
45 INSECTS. F. Balfour-Browne.
49 MARRIAGE. E. Westermarck.
57 ZOOLOGY. J. Graham Kerr.
63 X-RAYS AND RADIUM. V. E. Pullin.
64 MODERN PROBLEMS IN BIOLOGY. W. J. Dakin.
65 ENERGY. Sir Oliver Lodge.
66 BIRDS. E. M. Nicholson.
68 FUNGI. J. Ramsbottom.
75 EMBRYOLOGY. E. W. MacBride.
76 PARASITES. G. Lapage.
84 MATHEMATICS. S. Brodetsky.
90 FUEL. Sir Richard Redmayne.
91 GEOGRAPHY. H. J. Fleure.
95 INSECTS AND INDUSTRY. J. W. Munro.
96 AERONAUTICS. J. L. Nayler.
97 EARTHQUAKES AND VOLCANOES. J. W. Gregory.
101 MODERN SCIENTIFIC IDEAS. Sir Oliver Lodge.
102 THE AGE OF THE EARTH. Arthur Holmes.
103 THE ATOM. E. N. da C. Andrade.
104 CHEMISTRY. P. E. Spielmann.
105 RELATIVITY. J. Rice.
106 EARTH, SUN AND MOON. George Forbes.
107 THE STARS. George Forbes.
109 EVOLUTION. E. W. MacBride.
110 HEREDITY. F. A. E. Crew.
113 RACES OF MANKIND. H. J. Fleure.
114 MAN IN THE MAKING. R. R. Marrett.
115 PHYSICAL SCIENCE. J. Rice.
117 BIOLOGY. W. J. Dakin.
118 BOTANY. S. Mangham.
141 THE BODY. R. C. Macfie.
143 STRUCTURE OF MATTER. W. A. Caspari.
145 THE WEATHER. C. E. P. Brooks.
152 MIND AND ITS WORKINGS. C. E. M. Joad.
153 PSYCHO-ANALYSIS. Ernest Jones.

Obtainable of all Bookstalls, Booksellers and Newsagents
In case of difficulty write to-day to
ERNEST BENN, LIMITED, BOUVERIE HOUSE, FLEET STREET, LONDON, E.C.4

Monthly Metallurgical Section

Published in the first issue of "The Chemical Age" each month.

NOTICE.—Communications relating to editorial matter for our Monthly Metallurgical Section should be addressed to the Editor, THE CHEMICAL AGE, *Bouverie House, 154, Fleet Street, London, E.C.4. Communications relating to advertisements and other business should be addressed to the Manager. Contributions will be welcomed from correspondents on any points of interest to metallurgists bearing on works practice or current research problems.*

Copper Alloys Containing Silicon

(From a Correspondent)

The following is an account of the effect of silicon on the properties of copper and its alloys, and deals with alloys containing manganese, nickel, chromium, cobalt, and iron, as well as with certain brasses.

SILICON, usually in the form of copper-silicon alloy, is a well-known deoxidiser for copper, and the hardening effect of small amounts of this element on copper is generally recognised. To metals other than copper silicon has been added chiefly with the object of improving their resistance to acids and corrosion, and its successful use in the manufacture of aluminium cast alloys is well exemplified by alloys of the Alpax type, which are among the most satisfactory light casting alloys known. Until very recently, its use in copper alloys has been restricted to the addition of small amounts, chiefly for deoxidising and to a much lesser extent as a hardener, but during the last few years increasing attention has been given to the possibilities of copper alloys containing larger quantities of silicon.

Investigations of the System Copper-Silicon

Several investigations on the constitution of the copper-silicon system have been carried out, chief amongst which are those of Rudolfi[1], Sanfourche[2], Corson[3], Matuyama[4] and C. S. Smith[5], and in the light of the constitutional diagrams put forward by these workers it is possible to correlate the detached observations which have been made on physical properties of these alloys. The system is a fairly complex one, for within the region of about 6 to 16 per cent. silicon there are, according to Smith, six solid phases. With higher percentages of silicon the constitution is comparatively simple, being made up of silicon and a eutectic of silicon and the phase ε.

It is only those alloys the compositions of which are close to the copper end that possess useful physical properties. These alloys consist solely of one phase, the alpha solid solution, the limits of which vary with temperature. The limits of this phase have been determined by Smith[6], who found that it reached its maximum value at 6·7 per cent. silicon between 721° and 782° C., above which the solubility rapidly decreased to 5·25 per cent. at 852° C., the temperature of the peritectic horizontal. Below 721° C. the solubility decreases to 4·1 per cent. silicon at 400° C.

Properties of Low-Silicon Alloys

Silicon is sometimes added to copper in small amounts—usually up to about 0·1 per cent.—for the manufacture of telegraph and telephone wires, for this amount is sufficient to bring about some measure of hardening while only reducing the electrical conductivity to a value equal to about 80 per cent. of that or pure copper. The addition of small amounts of silicon to the metal is also made to improve the soundness of copper castings for electrical work. Aitchison and Barclay[7] gave the following figures showing the effect of small amounts of silicon on cast copper.

MATERIAL.	MAX. STRESS AS CAST, TONS/SQ. IN.
Electrolytic copper	10·8
,, ,, plus 0·25% silicon	14·5
,, ,, plus 0·53% silicon	15·5
,, ,, plus 1·05% silicon	17·4

Copper-silicon alloys containing up to 4–5 per cent. of silicon yield good castings, and alloys within this range of composition can be readily worked by drawing and hot or cold rolling. Castings possess quite good working properties, and rolled material is amenable to further working, such as spinning, drawing or stamping. When the silicon content begins to exceed about 5 per cent. the alloys rapidly become brittle. The widest application of the material low in silicon has undoubtedly been in the manufacture of wire, the strength of which varies up to 50 tons per square inch and over, depending on its size and condition. The effect of silicon in amounts up to about 5 per cent. is to increase the tensile strength and reduce the ductility. Actual values obtainable vary with the condition of the material, and rolled, annealed strip will give a tensile strength of about 28 to 35 tons depending on the silicon content, and elongations of the order of 30 to 60 per cent. The alloys also possess good resistance to corrosion, and in this connection some interesting data has been supplied by Bedworth[8] on copper-silicon-manganese alloys, which have to some extent been developed commercially.

Effect of Manganese

The addition of manganese is considered to increase the workability of copper-silicon alloys. The range of composition of the alloys tested by Bedworth was from 0·5 to 4·0 per cent. silicon with the silicon-manganese ratio kept constant at approximately 3 to 1. In these the material used was in the form of 0·183 in. diameter wire hard drawn and after annealing for half an hour at 750° C., and the corroding media were dilute hydrochloric acid (10 per cent. by weight) at room temperature and dilute sulphuric acid (10 per cent. by weight) at 60° C. The specimens were held alternately in acid and air for 1½ minute periods, the total time of test being 216 hours. The results obtained showed that additions of silicon and manganese up to 3 and 1 per cent. respectively increase the resistance to corrosion by these acids, and that no appreciable benefit is obtained by increasing these amounts.

The loss in weight in both hydrochloric and sulphuric acids decreases rapidly from 0·5 to 2 per cent. silicon, and in hydrochloric acid the loss in weight is practically constant with alloys containing from 2 to 4 per cent. of silicon, while in sulphuric acid it decreases slightly as the silicon increases from 2 to 4 per cent. Hard drawn wires containing more than 2 per cent. of silicon showed greater loss by corrosion than annealed wires of the same composition. Curves showing tensile strength and elongation of annealed wire after corrosion are practically parallel to those representing the original strength and elongation value. Hard drawn wire, however, containing 4 per cent. of silicon showed a much greater loss in tensile strength after corrosion than did hard drawn wires containing 3·2 per cent. of silicon, but the same difference did not exist between the corresponding annealed wires.

Mechanical Properties of Cu-Si-Mn Alloys

Alloys of copper with manganese and silicon are similar in mechanical properties to the straight copper-silicon alloys. They possess good corrosion resisting properties, and a patent alloy called Everdur, which comes within this class, has been developed especially for use in chemical plant in contact with hydrochloric acid. Its normal composition is 3½ per cent. of silicon, 1 per cent. of manganese and the remainder copper. The physical properties of this material in different forms are given by Bassett[9] as follows:—

	YIELD POINT. TONS/SQ.IN.	TENSILE STRENGTH. TONS/SQ.IN.	ELONGATION. PER CENT. ON 2 IN.	REDUCTION OF AREA. PER CENT.
Green Sand Castings	13·4	22·3	24	35
Forged Bar	18·0	29·0	54	60
Hot Rolled Rods	21·4	33·0	56	33
Rolled Sheets, Half Hard	25·0	35·7	40	—
Wire (Hard Drawn) ·025 in. dia.	—	70·0	—	—
Wire (Annealed) ·025 in. dia.	—	36·0	—	—
Cold Drawn Tubing (as drawn)	26·8	43·7	16	—
Cold Drawn Tubing (normalised)	22·0	30·8	42	—

The material yields good castings, has good machining properties, and is readily worked up into such forms as sheet, wire and tubing.

Effect of Other Metals

Hitherto most of the copper-rich alloys used in industry have not been amenable to heat treatment, excepting perhaps the aluminium bronzes, in a manner similar to that in which substantial improvements are brought about in aluminium alloys of the duralumin type. Recent work by Corson[3] has shown that marked improvements can be brought about in the properties of alloys of copper with silicon together with one of the elements, nickel, chromium, cobalt or iron. The amounts of silicon and the additional element present are such as to form one of the silicides Ni_2Si, Cr_2Si, Co_2Si and Fe_2Si. The copper content varies from 99·4 per cent in the case of copper-silicon-chromium alloys to 91 per cent. in the copper-silicon-nickel alloys.

In the soft state these alloys are readily workable, and can be rolled, spun, stamped and drawn into wire or tubing much in the same way as copper and brass. The underlying principles of the heat treatment processes are similar to those in the heat-treatable aluminium alloys, and depend on the differences in solubility of the silicides at elevated and normal temperatures. Thus in the case of the most soluble silicide, that of nickel, the solubility of nickel and silicon in solid copper is 0·7 and 0·15 per cent. respectively at ordinary temperature, and 7·3 per cent. of nickel and 1·7 per cent. of silicon at 980° C.

By heating the alloy to a temperature at which all the silicide is in solid solution, and quenching, the separation of the silicide is prevented. The subsequent treatment to develop the mechanical properties of the alloys consists of ageing them artificially by reheating to 350° C. for thirty hours, to 550° C. for half an hour. In this fully heat-treated form the yield point of the nickel alloys is about 33 and the tensile strength 50 tons per square inch, with an elongation of about 10 to 18 per cent. According to Gregg[10], silicon and beryllium together in copper endow it with age-hardening characteristics. So interesting are the properties and possibilities of copper alloys of this type that it would seem probable that their successful industrial application is not far distant, although the whole subject of age-hardening copper alloys has so far been studied only to a limited extent.

Brasses Containing Silicon and Nickel

The heat treatment and properties of three alpha brasses containing 3 per cent. of nickel plus silicon in the proportion necessary to form the compound Ni_2Si have been recently described by Ellis and Schumacher[11]. It was found that both in the cast and rolled condition the mechanical properties of the alloys could be varied within wide limits by suitable heat treatment. Brasses containing 10, 20 and 30 per cent. of zinc were studied, and the quenching temperatures, reheating or ageing temperature, and time necessary to yield the best combination of properties have been determined. From the properties given in the table below, which include values for 65/35 spring brass sheet obtained by van Deusen, Shaw and Davis, it will be seen that the ultimate strength and hardness of the nickel silver and brasses after heat treatment are similar to those of spring brass, but show a much higher ductility.

Composition Per Cent.			Heat Treatment.	Rockwell Hardness B Scale 100 Kg.	Limit of Proportionality Tons/sq. in.	Ultimate Strength Tons/sq. in.	Elongation % on 2 in.
Zn	Ni	Si					
9.89	2·32	0·57	Quenched from 800° C. Aged 1 hr. at 500° C.	86	20	40	14
19·89	2·37	0·57	Quenched from 850° C. Aged 1 hr. at 500° C.	85	16·5	38	21·5
30·12	2·36	0·66	Quenched from 800° C. Aged 1 hr. at 400° C.	79	17	38	28·0
35·0 (nominal)			Hard	88	15	41	3·5

By cold rolling the heat-treated sheets from a thickness of 0·04 inches, to 0·02 inches, the ultimate strength is raised to the order of 48 to 53 tons per square inch at the expense of the elongation, which falls to 2·0 to 3·0 per cent., and the Rockwell hardness is correspondingly raised by about 11 to 18 points. Cold rolling also reduces the modulus of elasticity of this heat-treated material. Observations on the crystal structure of the alloys indicate that silicon and nickel inhibit crystal growth. Preliminary experiments by the authors on phosphor bronze alloys containing 3 per cent. of nickel plus silicon and 4 and 8 per cent. of tin indicate that the properties of these alloys also can be varied by a heat treatment consisting of quenching followed by artificial ageing, the maximum hardness values obtained being equal to those obtained with the brasses containing similar quantities of nickel and silicon.

Just as in the case of heat-treatable aluminium alloys, one of the great advantages of these alloys is that they can be worked up into shape in the soft state, and then subsequently hardened and strengthened by heat treatment.

Bibliography

[1] E. Rudolfi, *Zeit. anorg. Chem.*, 1907, **53**, 216.
[2] M. A. Sanfourche, *Rev. Mét.*, 1919, **16**, 246.
[3] M. G. Corson, *Proc. Amer. Inst. Min. Met. Eng.*, 1927, 435.
[4] K. Matuyama, *Sci. Rep. Tohoku Imp. Univ.*, (1) 1928, **17**, 665.
[5] C. S. Smith, *Tech. Publn. No.* 142, *Amer. Inst. Min. Met. Eng.*, 1928.
[6] C. S. Smith, *Journal Inst. Met.*, 1928, **40**, 359.
[7] L. Aitchison and W. R. Barclay, *Engineering Non-Ferrous Metals and Alloys*, 1923, 121.
[8] H. A. Bedworth, *Tech. Publn. No.* 189, *Amer. Inst. Min. Met. Eng.*, 1929.
[9] W. H. Bassett, *Chem. and Met. Eng.*, 1926, **33**, 618.
[10] J. L. Gregg, *Tech. Publn. No.* 161, *Amer. Inst. Min. Met. Eng.*, 1929.
[11] W. C. Ellis and E. E. Schumacher, *Tech. Publn. No.* 188, *Amer. Inst. Min. Met. Eng.*, 1929.

Soil Corrosion of Pipe Materials

Recent Investigations

A GENERAL investigation of the soil-corrosion of pipe materials was begun in 1922 by the United States Bureau of Standards. The Bureau's Technologic Paper No. 368 gave the results of observations on specimens taken up for examination in 1924 and 1926. A second progress report including results of examination of the 1928 specimens has now been published as Research Paper No. 95 in the August number of the *Bureau of Standards Journal of Research*. This paper will soon be obtainable by purchase separately from the Superintendent of Documents, Government Printing Office.

The specimens treated in this paper include only ferrous pipe materials and cable sheaths. Soil characteristics, rather than differences in the composition of the ferrous pipe materials, appear to determine the type and extent of the corrosion observed. Tables in the paper show the relative corrosiveness of soils as indicated by rate of loss of weight and rate of increase in depth of pits. Although it happened that the same soil was worse from both these points of view, the soil that ranked next to the worst from the standpoint of pitting ranked twenty-eighth as to loss of weight. As the specimens in the ground grew older the corrosion became more general, and in most soils there was a decrease in the rate of penetration. Field examination of cast-iron gas mains in several cities yielded data of a similar nature. Considerable work has been done recently on methods of predetermining the corrosiveness of soils. The problem has not been solved.

The Various Factors Involved

Preliminary studies indicated that, in addition to the localised galvanic action caused by mill scale, differences in oxygen concentration, and other conditions, there are on pipe lines galvanic currents that result from the passing of the line through different soils. There appeared to be a relation between the discharge of these galvanic currents and the corrosion observed on the pipe line.

Additional specimens of pipe materials and coatings will probably be removed in 1930. In the meantime the Bureau is compelled to reiterate its former conclusion that no valid comparisons of the length of service of various materials can yet be made on the basis of the data obtained in this investigation.

Metallurgical Topics: Monthly Notes and Comments

From Our Own Correspondents

Empire Mining and Metallurgical Congress

THE Third (Triennial) Empire Mining and Metallurgical Congress will be held in South Africa from March 24 to May 9, 1930, beginning and ending at Cape Town. A brochure has been prepared and forwarded to all members of the constituent bodies of the Empire Council of Mining and Metallurgical Institutions, giving detailed arrangements of the two proposed tours, and incorporating information which would be useful to members from overseas, who contemplate taking part in the Congress. Reduced fares have been offered by several shipping companies. The cost of the tour, from date of arrival at Cape Town, will be £140 to £145, this being an inclusive charge for an itinerary covering 7,000 miles through the Union of South Africa and Southern and Northern Rhodesia. Travel will be by special train, which will cater for the greatest comfort and convenience of members.

The Programme of the Congress

AN attractive programme has been drawn up, which embraces sessions in Cape Town, Johannesburg, Bulawayo and Durban, with visits to mines and works and places of historical interest and scenic beauty throughout the country. Important technical papers dealing with different phases of mining, metallurgy and allied subjects will be presented and discussed. Local committees have been formed in each centre to be visited, to ensure that the varied tastes of the members, including the ladies, will be catered for in social functions, sport, etc. South Africa is a country of absorbing interest, especially to technical men, and, considering the reasonable cost, the places to be visited, and the distance to be covered, this tour should commend itself to all.

The fullest information may be obtained from the Secretary, Third (Triennial) Empire Mining and Metallurgical Congress, P.O. Box 4604, 100, Fox Street, Johannesburg, South Africa. In consideration of the shortness of the time available between now and the date of the opening of Congress, intending visitors, who have not done so, are urged to communicate with the above address without delay.

Aluminium Bronzes

E. MORLET, in the November issue of the *Récue de Metallurgie*, completes his account of the properties and behaviour of cupro-aluminium alloys containing manganese, tin and cobalt, and deals more particularly with alloys containing the latter metal. Cobalt of 99·8 per cent. purity was used in the experiments, and a copper-cobalt alloy prepared in the first instance as a method of introducing those metals into the aluminium melts. The alloy contained from 6·85 to 8·4 per cent. of cobalt, the remainder being copper. With this a series of cupro-aluminiums containing from 86·5 to 90 per cent. of copper, 6·5 to 10 per cent. of aluminium, and 0·5 to 3·5 per cent. of cobalt was prepared. In all of these iron was present, the percentage varying from 0·03 to 0·08. Two distinct types of structure were established, in one of which, the α-type, the cobalt is soluble to the extent of 1·27 per cent., while it is soluble to the extent of 1·66 per cent. in the (α + eutectoid) type. The surplus occurs in the form of needles and black specks at the crystal boundaries. The hardness and the resistivity of these alloys increase in proportion to the amount of cobalt present.

Influence of Tin and Manganese

THE conclusions arrived at in regard to the experiments on cupro-aluminiums containing manganese and tin, details of which were given in earlier instalments of the published researches, are summarised as follows: "The hardness of the alloys increase in proportion to the amount of manganese present, and so does the resistivity. On quenching, a martensitic structure is revealed and from a practical point of view the presence of manganese favours soundness and reduces blowholes and piping in ingots of the alloy. On the other hand, the presence of tin is definitely injurious, even when the percentage is very low. It makes the alloys brittle and unsound. Tin is, to a very considerable extent, soluble in the binary copper-aluminium alloys, which, after quenching, possess, for the most part, a distinctly martensitic structure, and behave as indifferently as alloys with such a structure usually do. A short bibliography of previous investigations on alloys containing these metals is appended.

Beryllium Alloys

ALTHOUGH the promise of beryllium remains a hope deferred, the latest bulletin of the Department of Commerce, Washington (Circular No. 6,100), by Miss A. V. Petar, on "Beryllium and Beryl," is not altogether discouraging. Much interest and thought are focussed on the possibilities of the metal and its alloys. In America, the Bureau of Standards, the National Advisory Committee for Aeronautics, and the Beryllium Corporation of America are studying the metal, which is being produced in Cleveland by the Corporation on a "semi-commercial" scale. The scientific world has been duly informed of the work of Siemens and Halske, of Berlin, while our own National Physical Laboratory has done a lot of good work both on the metal and on its alloys. It appears by now to be definitely known that even comparatively small percentages of beryllium greatly increase the hardness, strength and corrosion-resisting properties of many metals.

In the case of aluminium, a high-beryllium alloy is said to exhibit materially greater resistance to salt water and air corrosion than any other of the light alloys. Unfortunately, however, a high-beryllium alloy with aluminium is not, at present, a commercial proposition. Pure beryl contains 14 per cent. of beryllium oxide, but for the most part beryllium minerals do not contain much more than 5 per cent. of the metal, and even then cost something like 60 dollars per ton in New York, although America has many promising deposits. However, the prospect is held out from Germany of beryllium being produced at a very low price, when its potentialities will, assuredly, be very thoroughly exploited. The most promising direction is in the copper, nickel, and iron alloys of beryllium. Iron, with 2 per cent. of beryllium, rivals, in many respects, carbon steel, and is far more corrosion-resistant.

Competition Between Metals

ZINC and lead have been amongst the depressed industries during the concluding months of the past year, and tin is by no means satisfactorily situated. The non-ferrous metals and alloys are severely competitive amongst themselves, and have a tendency to supersede one another in their industrial applications. In the industries employing foil, aluminium is making large advances at the expense of tin; non-corroding cupro-nickels and similar alloys are competing with plain copper and brass tubing and fitments. Yet the non-ferrous metals and alloys are themselves subject to the extreme rivalry of ferrous alloys of the "stainless" kind. In this connection, even the light metals, hitherto regarded as indispensable in aeronautical engineering, are finding themselves in fierce competition with the stainless and rustless nickel and nickel-chromium steels.

In favour of the light metals, the argument used to be advanced that it was possible to use sections thick enough to withstand the stresses to which they might be subjected, and still make a lighter structure, on the whole, than when mild steel or some similar material was employed. Now the same argument is advanced in respect of rustless steel; it is possible to use such thin sections, owing to the high tensile strength of the material, that, in the aggregate, a lighter structure will stand up adequately to what is required of it. Even mild steel itself is threatened by the newer material, and the use of stainless steel in the building trades and in structural engineering is increasing by leaps and bounds.

Analysis of Foundry Materials

THE British Cast Iron Research Association has issued Research Report No. 72, "Recommended Methods for Sampling and Analysis of Foundry Materials" (pp. 16, 10s. 6d.). The Association is periodically confronted with difficulties arising from discrepancies in chemical analysis taken in different laboratories on what is presumed to be the same material, and due, at least in part, to differences in analytical technique and method. The recommended methods of sampling and analysis given in the report have been prepared

so that these discrepancies may be reduced to those dependent upon the human equation and upon the heterogeneity of material.

The methods have not been drawn up with a view to use by those without proper training in chemical analysis, and hence have not been elaborated to detail beyond the requirements of the trained works chemist. Neither is it suggested that they should be imposed upon chemists undertaking research or other work in which the chemist must be entirely free to choose the best methods for the particular conditions. The methods are intended solely for use in works and other laboratories engaged in conducting acceptance tests on raw material and material in process of manufacture. The use of standard irons as a check upon analytical methods is strongly recommended. The Association has found the following order of elements most convenient in reporting analyses of cast iron, and the methods are given in this order: Total carbon, graphite, combined carbon (by difference), silicon, manganese, sulphur, phosphorus, other elements (Ni, Cr, Va, Ti, Mo). The substances dealt with are pig iron, cast iron and malleable cast iron; and coke, coal dust, blackings and plumbagos.

The Late Dr. Mannaberg

THE death occurred recently, at his London residence, of Dr. Masmillian Mannaberg, at the age of 72. To Dr. Mannaberg was due much of the great development of the iron and steel industry of this country during a period of nearly forty years, and incidentally the industrial expansion of that part of North Lincolnshire with its centre at Frodingham, and the remarkable growth of the populous town of Scunthorpe. Born in a district of the former Austrian Empire which is now in Czechoslovakia, Dr. Mannaberg came to Great Britain in 1884 to assist, on behalf of the patentees, in introducing the basic Bessemer process at the Glasgow Iron and Steel Co.'s works at Wishaw. Three years later the Secretary of State for India sent him to Bengal to inquire into the possibility of making steel in India. About this time Messrs. Cliff, who were then engaged exclusively in the manufacture of iron at their Frodingham works, decided to extend their business to the making of basic open-hearth steel by the Gilchrist process, and Dr. Mannaberg was appointed to erect the new works. From that time until his retirement in the summer of 1920 he remained at Frodingham, in the meantime becoming a director, on the conversion of the firm into a limited company in 1902, and managing director in the following year.

For a time there was a difficulty in securing the recognition of steel made by the basic process, but Dr. Mannaberg, who was mainly responsible for the various expansions, succeeded in getting the name of the Frodingham company placed on the list of firms accepted by Lloyd's Register of Shipping and by the Admiralty for shipbuilding steel.

Possible Canadian Production of Radium Ore

THE occurrence of small quantities of radioactive minerals in granite pegmatite dykes in Ontario and Quebec was noted many years ago, when some of these dykes began to be worked for their mica or feldspar content. A considerable variety of rare-earth minerals, many of them radioactive, have been yielded by such dykes, but not in commercial quantities. Recently, however, prospecting in the Wilberforce district of central Ontario has resulted in the discovery of a deposit of uraninite that appears more likely to prove of commercial grade than any hitherto found in Canada. According to Mr. H. S. Spence, of the Mines Branch of the Dominion Department of Mines, the occurrence of small quantities of uraninite in a pegmatite dyke outcropping about one mile east of the village of Wilberforce, in Haliburton county, has been known for some years, but it is only during the last few months that a definite uraninite-bearing vein has been discovered. This vein is the first of its type to be found in Canada, and possibly is unique of its kind. It has been uncovered for a length of 150 ft. by the removal of a light dirt cover, and has been traced by outcrops for a further 400 ft.; its full length, however, has not yet been determined. Its width varies from 5 ft. to 10 ft. The uraninite occurs as scattered crystals or nodular masses through the vein-matter, some of the masses weighing several pounds. The vein has been subjected to considerable leaching by surface water, and much of the uraninite secured has been found as loose material in open cavities. The waters of springs issuing from the hillsides below the vein are reported to be strongly radioactive.

Several hundred acres of land around the discovery have been acquired by a Toronto Syndicate, the Ontario Radium Corporation, Ltd., of 539, Confederation Life Building, Toronto, and this company intends to proceed with development. Arrangements have been made with the Mines Branch of the Dominion Department of Mines to conduct a large-scale concentration test upon a car-load shipment of ore. The results of this test will be of interest, since it should determine whether the deposit possesses a sufficiently high radium content to justify exploitation. Analyses of the Wilberforce uraninite show a uranium oxide content of from 65 to 70 per cent. and a thorium oxide content of about 12 per cent.

Uraninite is a crystallised form of pitchblende, the richest commercial ore of radium, and is the mineral mined at Joachimsthal in Czechoslovakia, and in the Belgian Congo. From these deposits the greater part of the world's supply of radium has been obtained.

The Tin Situation in Canada

CASSITERITE, the ore of tin, is widely distributed throughout the world, but in only a few localities is it sufficiently concentrated to be of economic value. Tin deposits occur as lodes and as detrital and alluvial placers, and are usually associated with, or occur in the vicinity of, acid igneous rocks. The chief producing regions are the Straits Settlements, Bolivia, Dutch East Indies, Nigeria, Cornwall, China and Australia. The world's production in 1928 amounted to about 160,000 tons, of which about 33 per cent. was obtained from the Straits Settlements, 24 per cent. from Bolivia, and 17 per cent. from the Dutch East Indies.

According to Mr. Arthur Buisson, of the Mines Branch of the Dominion Department of Mines at Ottawa, no deposit of tin ore of economic importance has yet been discovered in Canada. Tin in the form of cassiterite has been found associated with various minerals in different parts of the Dominion. Its presence has also been noticed in the alluvial black sands of British Columbia, and it is known to occur in association with the zinc-lead ores of the Sullivan mine at Kimberley, British Columbia, where small recoveries have been made in an experimental way as a by-product in the concentration of the Sullivan ores. It is possible that research now being carried on by the Consolidated Mining and Smelting Co., at Trail, British Columbia, may result in the recovery of the tin and add another item to the already varied list of metals now being produced at the Tadanac plant.

Recent Discoveries

MUCH interest has been aroused in the past year by the discovery of occurrences of cassiterite in the central Manitoba mining area, and of stannite (a sulphide of tin) at the Snowflake property east of Revelstoke, British Columbia. Prospecting in central Manitoba by various operators has proved the occurrence of cassiterite over a wide area, and exploration operations in this district are being actively carried on.

At the Snowflake mine in British Columbia, stannite occurs in noticeable quantities in some workings. The mineralisation is very irregular in character, and the values obtained in the sampling by the officials of the British Columbia Department of Mines vary from a trace to about 6 per cent. tin. The combined average of several samples taken over an average width of 34 inches along the east drift and along a short raise from this drift is given as follows:—silver 6·39 oz. to the ton; zinc 5·31 per cent.; copper 0·94 per cent.; tin 0·73 per cent. A good deal of development work will be required to ascertain whether the mineral occurs in paying quantities. The occurrence at the Snowflake property is believed to be unique in that stannite, considered a comparatively rare mineral, is found here without any associated cassiterite, the recognised ore of tin.

A detailed description of the Snowflake property with a plan and an analysis of the ore is contained in the "Summary of Mining Operations for first six months of 1929," recently issued by the British Columbia Department of Mines, Victoria, B.C., which can be consulted in London either at the Canadian Building, Trafalgar Square, S.W.1, or at British Columbia House, 3, Regent Street, S.W.1.

Some Inventions of the Month

By Our Patents Correspondent

Abstracts of other Patents of metallurgical interest will be found in our Patent Literature, published weekly in THE CHEMICAL AGE.

Alloys

NON-MAGNETIC iron alloys having a "manganese equivalent" of about 12–16 per cent. are described in specification 320,332, dated April 4, 1928, by S. E. Dawson, of Cheadle Hulme, Cheshire. They contain less than 0·35 per cent. of carbon, not over 2 per cent. of silicon, 3–14 per cent. of manganese, and 3–12 per cent. of nickel, with or without 5–15 per cent. of chromium. For "manganese equivalent" purposes the effectiveness of metals is reckoned as Mn : Ni : Co = 1 : $\frac{1}{2}$: $\frac{2}{3}$. Reference has been directed by the Comptroller to specifications 178,820, 232,656 (see THE CHEMICAL AGE, Vol. XII, p. 47 [Metallurgical Section]), 275,322, 294,464, and 297,045.

BLOCK

Chromium Plating

METHODS of electroplating articles with chromium are described in specifications 320,440, 320,952, and 320,959, dated July 28, 1928, by Soc. Chimique de la Seine and V. Szidon, of Paris.

According to specification 320,440, the articles 10, Fig. 1, are supported from a copper bar, 6, adjustable vertically in insulating supports 7 to move a contact brush 11 over a

FIG. 1.

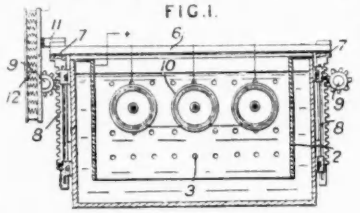


FIG. 2.

320,440

resistance 12, and thus regulate the current through the bath. The anodes comprise members 5, Fig. 2, shaped conformably to the articles to be plated and each provided with a tail-piece 4 mounted to slide in one of a series of holes 3 in a frame 2, supported in the bath.

According to specification 320,952, an electrolyte is used, comprising a solution of chromic acid containing small amounts of chromium sulphate and sodium carbonate, the current density being 0·9 amps. per square inch at 4–6 volts, and the distance between the electrodes being maintained as nearly uniform as possible.

According to specification 320,959, the articles to be plated are subjected to a preliminary heating and are immersed in the bath while still hot. For this purpose the articles may be connected together in the circuit of a heating current through the adjustable cathode support and a temporary connection to the positive terminal.

Copper

THE concentration of ores containing copper sulphide is facilitated by subjecting them to a preliminary heating, *e.g.*, to a red heat, with carbonaceous material in presence of free or combined halogen. The product may then be concentrated by froth-flotation, or in the case of mixed oxide-sulphide ores, the heating is continued until the copper which was present as oxide is caused to leave the ore particles, whereupon the product may be concentrated by flotation, gravity separation or otherwise. See specification 321,213, dated August 2, 1928, by H. Lavers and B. Taplin, of London.

Extracting Metals

To effect the reduction of compounds reducible by hydrogen carbon monoxide, or powdered carbon, but not dissociable by heat alone, such compounds are introduced, together with reducing agents, and with or without inert or reducing gases, into the hot free space of a chamber heated either externally or internally. Specified compounds so reducible are iron chloride, nickel bromide, copper chloride, cobalt iodide, osmium tetroxide and lead oxide. Acids, such as hydrochloric, which may be liberated, may be used for treating raw materials to obtain the compounds to be reduced. See specification 321,336 (Johnson), dated November 19, 1928, a communication from I.G. Farbenindustrie Akt.-Ges., of Frankfort-on-Main, Germany.

Steel

A STEEL alloy for constructional purposes contains up to about 0·4 per cent. of carbon, 0·5 per cent. of silicon, 2 per cent. of manganese or an equivalent metal, and 0·8 per cent. of copper. See Patent Application 319,319, bearing the International Convention date September 20, 1928, by F. Krupp Akt.-Ges., of Essen, Germany.

Treating Metallurgical Residues

A PROCESS for dressing residues containing metal (described in Patent Application 319,327, bearing the International Convention date September 20, 1928, by Hirsche Kupfer-und-Messingwerke Akt.-Ges., of Eberswalde, Germany), comprises the operations of (1) separating the metallic and non-metallic parts, *e.g.*, by blast-sorting or washing; (2) melting the metallic parts in an induction furnace; and (3) dressing the non-metallic parts separately by reduction or by leaching, followed by chemical or electrolytic deposition.

Steel Industries Combine

IN view of the position of the Austin Friars Trust, there has naturally been much doubt as to the effect on the merger, which had been arranged, of several important steel firms. It now appears from the speech of the chairman at the recent statutory meeting of the Steel Industries of Great Britain, that, apart from one or two outstanding matters, the company is not affected by recent events. The Austin Friars Trust sold to the Steel Industries the shares and securities of the United Steel Companies and its subsidiaries, and the primary object of the formation of the combine was achieved by the acquisition of 97·5 per cent. of the securities of the merging companies. The Austin Friars Trust undertook, if the offer became absolute, to provide funds sufficient to discharge the indebtedness of the steel companies to their bankers and to provide adequate working capital. Further, as soon as practicable, to carry out a reorganisation scheme.

A deposit was made by the Austin Friars Trust in case it should fail to carry out its obligations. The Trust completed its obligation to purchase the holdings of the steel companies, and the Steel Industries therefore became proprietors of the entire capital transferred. The assets of this new undertaking are not affected by the failure of the Austin Friars Trust. The two other obligations have not been fulfilled. It appears that documents purporting to be allotment letters of shares in the combine have been issued representing 261,000 ordinary and 170,349 preference shares. The view of the directors and their adviser "is that these documents having been issued without the consent or knowledge of the directors, and without any allotment being made, are not binding on the company." Legal proceedings in connection have been instituted by a holder. The main point is that the amalgamation has been carried through and the combine established. It is now proposed to put into effect the scheme of reorganisation originally contemplated.

The Mond Nickel Co.

THE MOND NICKEL CO. has issued the following statement: With reference to the reduction of capital, recently sanctioned by an order of the Court, the company desire to draw attention to certain reports which have appeared in the Press, describing the reduction as a "cut" in capital. The company wish to make it clear that the reduction has not arisen from losses, as is usually implied by the word "cut." Precisely the contrary is the case, namely, that there has been an actual repayment of surplus funds no longer required in the business. It has also been reported that the assets, both in Canada and the United Kingdom, have been written up appreciably, whereas in fact only the assets in Canada were written up. The capital reserve is £6,583,245, and will only be reduced by £406,250, being the premium payable on the repayment of the cumulative preference capital, thus leaving a balance on the reserve of £6,176,995, and not £2,400,000 as reported.

Current Articles Worth Noting

We give below a brief index to current articles in the technical Press dealing with metallurgical subjects.

ALLOYS.—The formation of the γ-phase in the silver-zinc alloys. G. J. Petrenko and B. G. Petrenko. *Zeitschrift anorganische Chem.*, Vol. 185, Parts 1–2, pp. 96–100 (in German). The γ-phase is formed at the peritectic temperature of 665° C. according to the equation β-mixed crystals (49 per cent. Zn.)+melt with 49 per cent. zinc $\rightleftarrows$ γ-mixed crystal (47·61 per cent. zinc). The γ-phase has its transformation point at 225° C.; at lower temperatures it appears as the chemical compound Ag_2Zn_3.

ALUMINIUM.—The corrosion of aluminium. H. Röhrig. *Korrosion und Metallschutz*, November, pp. 244–245 (in German).

ANALYSIS.—Total analysis of antimony ores, high-antimony alloys and antimony regulus. H. Blahetek. *Chemiker-Zeitung*, December 25, pp. 995–996 (in German).

The rapid determination of iron in nickel baths. O. Grube. *Chemiker-Zeitung*, December 4, p. 935 (in German).

Tungsten-chromium-vanadium determination in high-speed steels. W. Brüggemann. *Chemiker-Zeitung*, November 30, pp. 927–928; December 7, pp. 947–950 (in German).

BRASS.—The effect of lead on the (alpha+beta)-beta equilibrium in a 60/40 brass (Muntz metal). L. R. van Wert. *Metals and Alloys*, November, pp. 200–205.

CORROSION.—The cause of intense corrosion on the external plates of ocean steamers. M. Rudolph. *Korrosion und Metallschutz*, November, pp. 246–247 (in German).

Corrosion experiments with Monel metal and acid-resistant bronze. M. G. Binek. *Korrosion und Metallschutz*, November, pp. 246–247 (in German).

GENERAL.—The melting points of calcium, strontium and barium. H. Hartmann and G. May. *Zeitschrift angewandte Chem.*, Vol. 185, Parts 1–2, pp. 167–171 (in German). The melting points (in an argon atmosphere) are as follows:—Ca, 810° C.; Sr, 752±2° C.; and Ba, 658±1° C.

Röntgenographic investigations on the system cadmium-antimony. F. Halla and J. Adler. *Zeitschrift angewandte Chem.*, Vol. 185, Parts 1–2, pp. 184–192 (in German).

Poly-component systems with iron. II.—The system chromium-carbon. R. Kraiczek and F. Sauerwald. *Zeitschrift anorganische Chem.*, Vol. 185, Parts 1–2, pp. 193–216 (in German).

The permeability of metals to gases. The actual state of the question. Comparison of results. An attempt at the classification of various gas-metal systems studied. V. Lombard. *Revue de Métallurgie*, October, pp. 519–531 (in French).

The present status of cemented tungsten carbide tools and dies. Z. Jeffries. *Metals and Alloys*, November, pp. 222–225.

Properties of nickel in caustic evaporation. R. J. McKay. *Ind. Eng. Chem.*, December, pp. 1283–1287.

Practical experiences in the protection of boiler parts against burning by the aluminisation process (Alumetierverfahren). C. Commentz. *Korrosion und Metallschutz*, November, pp. 248–249 (in German).

The present position of metallurgy in Australia. C. Blazey. *Chem. Engineering and Mining* (Australia), November, pp. 45–48.

HEAT TREATMENT.—Effect of atmosphere on the heat treatment of metals. E. G. de Coriolis and R. J. Cowan. *Ind. Eng. Chem.*, December, pp. 1164–1168.

IRON.—Malleable iron—short cycle anneal. I. R. Valentine. *Metals and Alloys*, November, pp. 233–234.

IRON, CAST.—An investigation of various cast irons containing nickel and copper. M. Ballay. *Revue de Métallurgie*, October, pp. 538–553 (in French).

MACHINERY.—A new automatic metallographic polishing machine. S. Epstein and J. P. Buckley. *Metals and Alloys*, November, pp. 226–231.

NITRIDED IRON AND STEEL.—Observations on the iron-nitrogen system. S. Epstein.—A study of the nitriding process. I.—V. O. Homerberg and J. P. Walsted.—The nitriding process. A. Fry.—Researches on nitriding steels. O. E. Harder, J. T. Gow and L. A. Willey.—Investigations in nitriding. R. Sargeson.—Short-time nitriding of steels in molten cyanides. A. B. Kinzel and J. J. Egan.—A few practical fundamentals of the nitriding. H. W. McQuaid and W. J. Ketcham.—Use of nitrided steel in high pressure steam service. V. T. Malcolm. *Transactions Amer. Soc. Steel Treating*, Vol. XVI, No. 5 (Nitriding Symposium Edition), pp. 19–65, 67–110, 111–118, 119–144, 145–174, 175–182, 182–203, 205–216.

PASSIVITY.—The passivity of metals. III.—The quantity and distribution of the superficial oxide. U. R. Evans and J. Stockdale. *Journ. Chem. Soc.*, November, pp. 2651–2660. A new method for the removal of the surface skins of metals, dependent on anodic undermining, has been worked out: it is often possible to transfer the film to glass coated with nitrocellulose. Films have been removed from several fresh materials, such as nickel and carbon steel, and a transparent skin has been isolated from stainless steel.

RECRYSTALLISATION.—The theory of recrystallisation. G. Tammann. *Zeitschrift anorganische Chem.*, Vol. 185, Parts 1–2, pp. 1–34 (in German).

SEGREGATION.—The configuration of the segregation of ingots after solidification. G. d'Huart. *Revue de Métallurgie*, October, pp. 532–537 (in French).

STEEL.—Recent developments in corrosion-resistant and heat-resistant steels. J. A. Matthews. *Ind. Eng. Chem.*, December, pp. 1158–1164.

Dilatation of steel during quenching. G. M. Eaton. *Transactions Amer. Soc. Steel Treating*, December, pp. 819–859.

Selection of case-hardemed steels for highly stressed gears. H. W. McQuaid and O. W. McMullan. *Transactions Amer. Soc. Steel Treating*, December, pp. 860–892.

A study of burning and overheating of steel. III.—W. E. Jominy. *Transactions Amer. Soc. Steel Treating*, December, pp. 893–936.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

Mortgages and Charges

[*NOTE.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case, the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.*]

BIRTLEY IRON CO., LTD.—Registered November 26, £10,000 further charge (supplemental to mortgage and debenture dated July 19, 1928), to D. M. Muir, 44, Grey Street, Newcastle-on-Tyne, and another; charged as in principal deeds. *£20,000. December 31, 1928.

CLARK (F. A.) AND SON, LTD., London, W., lead merchants.—Registered December 6, debentures for £15,000 and further advances not exceeding £5,000, £5,500 and further advances not exceeding £2,500 and £2,000, to F. C. B. Clark, 75 Eaton Square, S.W., F. H. B. Clark, 7, York House, Church Street, Kensington, and said F. H. B. Clark and others; general charges. *£52,500. June 27, 1929.

HAMMOND (WILLIAM) AND CO. (SYSTON) LTD., ironfounders.—Registered November 30, £3,000 2nd debenture, to Peoples Bank, Ltd., Nottingham; general charge. *£6,604. December 13, 1928.

Satisfactions

BWANA M'KUBWA COPPER MINING CO., LTD., London, E.C.—Satisfaction registered November 19, £17,550, part of amount registered, April 13, 1928.

PARK FOUNDRY CO., LTD., Derby.—Satisfactions registered, November 18, £1,500, registered June 8, 1903; also registered November 25, £50,000, amount outstanding July 1, 1908.

Monthly Metallurgical Section

Published in the first issue of "The Chemical Age" each month.

NOTICE.—Communications relating to editorial matter for our Monthly Metallurgical Section should be addressed to the Editor, THE CHEMICAL AGE, *Bouverie House, 154, Fleet Street, London, E.C.4. Communications relating to advertisements and other business should be addressed to the Manager. Contributions will be welcomed from correspondents on any points of interest to metallurgists bearing on works practice or current research problems.*

Recent Progress in Electrodeposition

The Presidential Address to the Electroplaters' and Depositors' Technical Society

At the recent annual general meeting of the Electroplaters' and Depositors' Technical Society, the new president, Dr. R. S. Hutton, Director of the British Non-Ferrous Metals Research Association, was inducted into the chair by Mr. S. Field, A.R.C.S., who has retired from the presidency after three years of successful and active service. Dr. Hutton delivered his presidential address, entitled "The Recent Awakening of the Electro-Depositing Industry."

DEALING first with the progressive spirit of the early pioneers, Dr. Hutton said that it was only in 1836 that Professor J. F. Daniell, of King's College, London, made available the first constant current battery. All early electroplating was carried out with such batteries, and although the magnetic machine of Woolwich appeared in 1844 and was at once taken up by the few electroplaters of the day, among them by Dr. Hutton's grandfather, the information at our disposal showed that the magnetic machine needed very close attention and was thought by many to be inferior to the chemical batteries. Only in 1867, when Henry Wilde brought out his dynamos, did the difficulties connected with the source of electric current begin to disappear.

Undoubtedly the foresight and keenness of the Elkingtons, backed up by the great Josiah Mason of Birmingham, played a most important part in the progress of electrodeposition from its inception in 1838 onwards until copper refining was started by them in South Wales in 1867.

The Work of the Pioneers

The term "electroplating," at first confined to silver plating, was generally extended, and now covered practically the whole field where surface coating by electrolytic means was concerned. Considering the very crude plant, the lack of satisfactory apparatus for measurement or control, and the poor quality of the chemicals available in those early days, Dr. Hutton said that he was sure that all modern electroplaters would agree with him that their deep respect was due to the splendid work of the early pioneers.

Unfortunately, the pioneer period having passed, the fraternity of electroplaters seemed for a long time to have dug themselves in, relying more on their inheritance from the past than on their own contributions to the advancement of the science and art of electrodeposition. Under such circumstances it was astonishing what small-minded ideas developed of the value of secrecy and occultism. All such ideas were directly antagonistic to progress, and anyone who studied the history of this or any other branch of technology would agree—in fact, could have foretold—that real prosperity depended rather upon venturing into new fields and reaching out for something well in advance of the practice which had been inherited.

Within the last few years, the whole outlook in that respect had shown a marked improvement. Wider objectives had opened out, a number of other metals had been added to the palette of the plater, and he was now able and willing, not merely to decorate the knick-knacks of the wealthy, but to afford a high measure of protection to structures, and even to offer the engineer improved strength and hardness, opening up many new possibilities.

Research and the Electroplating Industry

It always seemed to him, said Dr. Hutton, that the industry was benefiting perhaps even more from the advance of knowledge in subjects which at first sight only indirectly concerned it, than from that in the science of electrodeposition itself. All the newer applications depended so much on the properties of the metal coating. For instance, recent research had given them quite new conceptions of the whole mechanism of corrosion and tarnishing, but extensive though this work had been, it but pointed the way for much further knowledge, for undoubtedly systematic research should lead them to a much better choice of metallic coatings for withstanding discoloration or more serious attack under severe conditions of service.

Dr. Hutton referred to the very close link between electroplating and the polishing of metals. It had always appeared to him curious that the polishing and finishing of metals did not receive more study and attention. In many metal industries, the percentage of the total cost due to polishing was very high, yet seldom if ever did one hear of systematic attempts to attack the basic principles and to find ways of reducing the cost.

Some years ago, when he was in the silverplating trade, he was so impressed with the high cost and the obviously trying conditions of the work of women engaged on buffing nickel-silver spoons and forks, that he persuaded the Industrial Fatigue Research Board to make a scientific study of the whole process. Their report on this subject was one which had received far too little attention. Knowing this branch of production, he was convinced that large savings in cost could be readily effected by anyone who took the trouble to organise production along proper lines, and yet so far as he was aware practically no use whatever had been made in this industry of the help thus put at its disposal.

The Organisation of Research

In many cases more attention should be paid to the proper planning of electrodeposition research than was always the case at present. He referred more to what might perhaps be termed industrial research on electrodeposition. Here it was necessary to start with as well-defined plans as possible, and if, as was usually the case, the work was being carried out with the object of proving of direct use and application it was important that the conditions of such uses and application be borne in mind. For instance, in investigating a new method of deposition it was sometimes annoying to find a mass of data on the influence of the electrolyte, temperature, current density and what not on the efficiency of the metal depositions, but no record or trial of the adhesion of the metal, its freedom from pinholes or other defects, or how permanent it was after prolonged exposure. If only the optimistic workers who one after another claimed to have discovered the ideal process for electroplating aluminium had carried out their work on some such basis, what a vast amount of disappointment would have been avoided.

Chromium Plating

Within the short life of that Society they had seen chromium plating arise and exert a great influence on the industry. It was probably the ease of oxidation, rather than its unattackability, which made chromium so valuable as a surface coating or as an alloy constituent, and what they needed to do to achieve still further advance was to study the properties and the optimum conditions of formation of those thin and invisible oxide films, not only with chromium but also with other metals and with alloys.

Until quite recently the search was for "super-metals" (which generally meant "noble"), with their characteristic high prices. To-day they knew that non-corrodible and non-tarnishing properties depended on "passivity" or the powe of forming invisible protective films, and the search migh

thus be made among relatively cheap and common metals, trying to find the best condition to assure the particular service they had in view.

The future outlook of chromium plating appeared to be much wider now that its use on adequately protective undercoatings of nickel was more generally understood. The possibility of applying chromium—" the spirit of stainless steel "—to the surface while retaining all the great economic advantages in selecting a material which could be cheaply formed and polished was of the greatest importance in the manufacture of metal articles and fittings.

Another direction in which he believed electrodeposits would find a wide use, despite early disappointments, was in the " cementation " of steel and other underlying metals for their applications in high temperature service. Abroad, quite a number of investigations had been reported in which chromium, zirconium and other metals have been made to penetrate by diffusion the surface layers of steel, thus affording protection and other good properties. The application of chromium to the protection of the mould used in the pressed glass industry was said to be of great economic importance.

Appeal for Co-operation in Research

The Electroplaters' and Depositors' Technical Society had played a most important part in encouraging discussions and intercourse between those engaged in different sections of the industry. It seemed to him, however, that much more was required. The progress of the industry depended most certainly upon more active co-operation in pushing forward the limits of their knowledge, and the more intimately they could themselves participate in those advances, the easier would it be for them to harness them to their daily industrial problems.

Within the last three or four years large sums had been devoted from outside the industry to subsidise research on electrodeposition. The Department of Scientific and Industrial Research had expended over this period at least £1,500 per annum.

The British Non-Ferrous Metals Research Association had contributed to those researches, and had itself voted additional funds, largely provided by the Mond Nickel Co., Ltd., to other investigations on electrodeposition. Moreover, that Research Association had carried out for many years systematic research on the atmospheric corrosion and tarnishing of metals, which had a direct bearing on their field of interest. All that research had undoubtedly yielded important results.

More Funds Required

But the work would be more readily brought home to industrial appreciation and use, if, in steadily increasing measure, the industry itself could provide some part of the funds required. In fact, the continuation of the researches might at any moment depend upon support being provided by the electrodeposition industry itself. In the U.S.A. a similar state of affairs had existed. The U.S. Bureau of Standards subsidised research for some years unaided by the industry, but recently a research fund had been mobilised, and a large number of small individual firms had been found ready to contribute £100 or more.

The British Non-Ferrous Metals Research Association had a minimum membership subscription of £25 per annum. The subscriptions entitled members to share in the results of all the sections of the whole metallurgical programme which might be of interest to them and to other services afforded by the Association, such as information, development, etc.

For small firms only engaged on electrodeposition, participation in this research by membership of the Association might make rather too high an individual levy, at any rate at the start, but a scheme could be devised in which the Society might co-operate with the Research Association for mobilising some fund to support electrodeposition research with individual contributions varying in accordance with the means of the individual, and based, say, on a minimum of £10 per annum.

A really enthusiastic effort along those lines might surely produce quite a substantial total fund, and apart from bringing the needs of the industry more clearly into the research programme, would encourage the continued expenditure by the Department of Scientific and Industrial Research on a scale which at present was apparently far beyond the means of the electrodeposition industry itself.

Protective Coatings for Iron and Steel

The Prevention of Corrosion

In the course of a paper before the North-Western Branch of the Institution of Mechanical Engineers at Manchester recently, Mr. E. O. Jones discussed protective coatings for iron and steel.

Mr. Jones said that to prevent corrosion entirely was probably impossible, and where the corrosion was general it would be very slow and would not constitute a dangerous condition. Localised corrosion was much more serious ; it was a frequent cause of failure, and, therefore, the most expensive and objectionable form of corrosion, and might be a source of serious danger. By the exercise of suitable precautions it should be possible to obviate this localised corrosion, but it was essential to have a thorough understanding of the cause of corrosion in order to choose the right remedy.

Preventive methods which might be useful in certain circumstances might be positively dangerous in others. The various types of protective coatings which might be applied to a metal to improve its corrosion-resistance were :—Another (more resistant) metal ; paint, lacquer or varnish ; tarry or bituminous paint ; cement or concrete ; glassy enamels ; oxide or phosphate films ; or films of grease or oil. After discussing the application of metallic coatings at some length, referring in particular to the dipping, electrodeposition, sherardising, calorising, chromising, and metal spraying processes, the author went on to deal with the application of paints, varnishes and other materials.

Paints

Paint coatings, he said, protected the underlying metal by mechanical action, and offered the advantage over cathodic coverings in that, being non-conducting, no electrochemical action between the coat and any exposed metal would result. The exposed steel would, of course, rust, but the corrosion at these parts was not likely to be more rapid than if the whole surface were bare ; indeed, the rust, by choking up the pores, might actually stifle corrosion to a certain extent. Paint coatings also permitted the use of an almost unlimited number of colours and finishes for decorative purposes. As against these advantages, they suffered from the defect of deterioration in service as a result of the softening effect of the alkali produced as the cathodic-corrosion product, or the expansive force of the voluminous rust product if formed underneath the paint layer.

Constituents of Paint

Paints had essentially four constituents :—

(1) A drying oil or vehicle such as linseed oil, which was converted by polymerisation and oxidation into a solid transparent film of linoxyn. Oil which had been heat treated or boiled was a more satisfactory vehicle than raw oil, as it dried much more rapidly and afforded better protection from corrosion. Another drying oil which was often used was China wood oil (tung oil).

(2) A drier or mixture of driers which catalysed the oxygenation of the vehicle and accelerated the drying of the paint. Oxides of lead, manganese and cobalt were commonly used for this purpose.

(3) A pigment or mixture of pigments. The chief functions of the pigments, apart from any decorative effects, was to give the necessary hardness and mechanical strength to the linoxyn film and to reduce its permeability. The paint coat had to be sufficiently hard to withstand the abrasion likely to be met with in service, but yet had also to be sufficiently tough to respond without cracking to any bending or denting the

material might undergo. If likely to be subject to temperature fluctuations, its coefficient of expansion was also important, and in this connection metallic pigments which would have expansions comparable with the basis metal, and, therefore, lessened the strain on the linoxyn, had special value and in general gave excellent results. Although the main function of the pigment was mechanical, yet pigments might influence the corrosion of the underlying body, and due regard to this fact must be paid in choosing or compounding a paint for the priming coat. Thus carbonaceous pigments, with the exception of willow charcoal, which contained wood ash and was, therefore, alkaline, tended to stimulate corrosion, probably functioning as cathodic members of corrosion couples, whilst basic or oxidising agents in general inhibited corrosion by maintaining a passive oxide film.

(4) A thinner such as turpentine, which merely reduced the consistency of the paint to a suitable value and evaporated off during the drying stage.

Technique of Paint Application

Since, said the author, all paint films were more or less porous, it was advisable to apply more than one coat to increase the resistance to moisture penetration, and Andes considered that one priming coat and four top coats were needed to give adequate protection to iron. As had already been indicated, the choice of the pigment in the primary coating was governed largely by electrochemical considerations, whilst those of the finishing coats would be chosen from the mechanical point of view, since their main function was to give the required toughness and strength. Nevertheless, the chemical properties of the pigments in the outer coats could not be entirely negligible. It would, for example, be useless to use iron oxide paints in chemical works where the atmosphere was strongly polluted with acid fumes.

The question of the preliminary treatment for the removal of scale or rust before painting was of interest. Where the scale coat was intact and adherent it was in itself a protective layer against corrosion, and could be safely left in position. This applied to cast iron, and if painting were carried out before the scale layer had suffered damage there would be little danger of peeling. In the case of steel, there was always the liability of the scale loosening, and for this reason complete descaling was generally recommended, though no serious results were likely to occur if the adherent portions were allowed to remain during the life of the first painting and removed with the old paint when the time for repainting came round.

Old rust should be removed completely since, although in a completely dessicated state it was like adherent scale, there was always the liability that it would contain soluble and hygroscopic salts which would promote corrosion and peeling. When applying the paint, it was very important not to entrap moisture, and for this reason one should avoid those occasions when the metal was either wet from rain or had a dew film. Gentle heating with a painter's blowlamp to ensure complete dryness would often be beneficial

Bituminous Paints

Bituminous and tarry paints were largely used for the protection of metal work against atmospheric attack, especially where acid fumes were present as, for example, in chemical works ; for the protection of metal immersed in saline waters, as in marine engineering ; and for the protection of pipe lines from stray currents, for which purpose they were particularly suited, since they were good insulators. This class of material was more resistant to acid fumes than linseed oil paints, and was, therefore, much more suitable for combating corrosion where the atmosphere was highly polluted, but care should be taken in the choice of the material used. Those high in hard bitumen produced a film which was either brittle and powdery, or was so strong mechanically that it lifted in large areas and peeled off under the expansive force of rust formation, and thus gave little protection. A weaker film which " gave " to this force would not flake off so readily, and would, therefore, be more effective.

Harvey recommended a mixture of coal tar and 10 per cent. of lime, which was gradually heated to 200° C. and maintained at this temperature for about 15 minutes. A hard bitumen such as gilsonite was added in the proportion of 4 lb. per gallon, and heating continued until the mixture was homogeneous. It was then allowed to cool down, half its volume of crude benzole stirred in, and the mixture allowed to cool in an air-tight vessel.

In the case of immersed corrosion, the attack was downward rather than lateral, and so there was less tendency for peeling. Harder coats could, therefore, be used if resistance to abrasion, etc., demanded it. The importance of absence of moisture and good adhesion was as great with this class of paints as with the other, and from this point of view it was recommended that (*a*) the tarry and oily constituents should be subjected to a preliminary heating to expel the volatile constituents and traces of water ; and (*b*) the metal should be pre-heated where possible to dry the article thoroughly, to open the pores of the metal so that they might be filled with the paint, and to expel absorbed gases.

Bituminous paints, said Mr. Jones, had been used for the interior protection of pipes, but the difficulty of obtaining a smooth surface which would neither afford places of lodgment for scale or solid bodies nor offer too much frictional resistance to the water flow had been a serious objection. Recently, glass-smooth surfaces had been obtained by spinning, and a still more recent development made use of cataphoresis (which was the basis of the electrodeposition of such colloidal materials as rubber) for the deposition of a bituminous layer.

Enamel Coatings

After dealing briefly with concrete and cement, the author turned his attention to vitreous enamel coatings, which, he said, consisted of a mixture of silicates of such metals as sodium, calcium, aluminium or potassium, together with borax to increase the fluidity, and such materials as stannic oxide, cryolite, antimonius oxide or titanium oxide to render them opaque. Colouring pigments (which must be stable at the high temperatures involved) were used if desired, very largely for cooking utensils and also in the chemical industries.

Vitreous enamel coatings were extremely resistant to corrosive media, and had a very high electrical resistance, which made them effective corrosion preventatives ; but, since this protection was purely mechanical, their brittleness and liability to chip were a considerable drawback for material which had to withstand hard usage. Of recent years, considerable improvement in toughness had resulted in modern enamels being distinctly superior to the earlier ones, and this no doubt accounted for the more extended use which was being made of them. In proportioning an enamel, the surface tension must be carefully regulated so that it would produce a smooth coating, but must not be so high that parts of the basis metal were not properly wetted.

Grease and Oil Coatings

Oxide layers and similar coatings were next considered, and finally the author referred to grease and oil films. The use of grease and oil on the parts of machinery which could not be coated by one of the methods indicated was well known and called for no comment. It only remained to make a brief mention of coatings for metal articles in temporary storage. Researches at the National Physical Laboratory had shown that a solution of lanoline in benzine was very satisfactory, whilst if a coloured slushing compound was desired the United States Paint Manufacturers' Association recommended a mixture of zinc dust and aluminium powder in heavy petroleum jelly. Such a coating could be readily removed when required by means of paraffin.

In conclusion, the author stated that there was no perfect protective coating which would satisfy all conditions. Every corrosion problem was an individual one, and needed careful consideration as to the most appropriate protective medium, since an injudicious choice might easily intensify instead of mitigating the trouble. Coatings aimed in general at the complete exclusion of the corrosive medium, and should, therefore, be chosen with respect to their appropriate chemical resistance, but, in addition, since all coatings were pervious to a certain extent either as a result of porosity or cracks due to abrasion or bending, the question of electrochemical reactions at the discontinuities must be taken into account, both from the point of view of the influence of the coating on the reactions themselves and the nature and position of the corrosive products, both primary and secondary.

Metallurgical Topics: Monthly Notes and Comments

From Our Own Correspondents

Mond Nickel Precious Metal Refinery

WHEN the Mond Nickel Co. has finished its extensions at its refinery and research laboratory, Bashly Road, North Acton, London, the works will form the largest refinery of precious metals (gold, silver, platinum, etc.) in the world. The ore residue concentrates, after the extraction of nickel and copper, come to Acton from Clydach, South Wales, and Ontario.

The first step towards the erection of the extension, which will be 160 ft. by 52 ft. and 50 ft. in height, and will cost about £70,000, was taken on Saturday, January 25, when Mr. D. O. Evans (delegate director in this country) and Mrs. Evans visited the Acton Refinery, and Mrs. Evans cut the first sod in the adjoining field.

Mr. Evans said that, in view of present-day industrial conditions, it was all the more encouraging to know that they were associated with a progressive international company that went on extending in all directions. The whole work of their great combination in regard to the metals with which they were concerned would be concentrated in that spot, and when the premises had been fully extended they would compose the largest refinery for precious metals in the world. That was a matter for national pride. In London, in Acton, in South Wales, in Birmingham, and in Canada, they had a great organisation in which all, from those at the top to the juniors, were equally pulling their weight and always doing a fair day's work in the production of wealth.

A Septenary Alloy

COMPLEX aluminium alloys still attract the attention of the metallurgist in direct proportion to the number of elements contained therein. There are snags in the manufacture and use of the binary alloys, and more in regard to the ternary alloys. One way of attacking the problems of unexpected weakness, lack of desirable properties or of casting or working difficulties, etc., is to take some well-known alloy and try the effect of further additions—not, that is, of the copper, magnesium or silicon already contained therein, but of new elements. Sometimes the method works. Such was the case of "Hiduminium, R.R.50" developed by Hall and Bradbury in the laboratory of Rolls-Royce, Ltd. Mr. W. C. Devereux, in a recent paper, drew attention to some of the advantages of this alloy compared with the older aluminium-silicon alloys. By all accounts it lives up to its name, having been liberally used in the engine installed in the winner of last year's Schneider Trophy race. Some elasticity of composition is permissible and even desirable when diverse applications of the alloy are to be made. "Hiduminium" has a wide range of composition—copper 0·5 to 5·0 per cent., nickel 0·2 to 1·5, magnesium 0·1 to 5·0, iron 0·6 to 1·5, silicon 0·2 to 5·0, and titanium up to 0·5 per cent., the remainder being aluminium.

Particular ranges of composition are assigned for general purpose, sand and die castings; for piston die castings; for general purpose forgings, and for high quality forgings for pistons. All four grades are amenable to heat treatment, improvement in strength resulting. The alloy appears to be the most easily cast and forged of all the aluminium alloys. Cases are on record of the use of this alloy permitting of the elimination of numerous chills from the moulding process. While aluminium-silicon alloys, modified, have achieved a large measure of success, they require skill in casting and are not always suitable in circumstances which necessitate their being kept molten for long periods, owing to the possibility of undesirable reversion. The new alloy is fortunately free from this objection, and from hot shortness and shrinkage cracks. It has a high proof stress and gives a dense casting. Some care and properly raked tools are necessary if machining is to be good at an economic price, but any alloy for high duty work deserves careful treatment, and the machining properties of "Hiduminium" are now well understood.

X-Ray Distinction between Metals and Alloys

IT is a number of years since research was endowed with a new method of investigation by means of X-ray analysis. Most of the work hitherto done has been of a physico-chemical nature, or mineralogical, or, so far as metallurgy is concerned, of the type bearing upon the atomic and crystallographic structure of single metals, and not a great deal has been done on alloys. A. Roux and J. Cournot, in the latest issue of *La Revue de Métallurgie*, describe a series of investigations on a more purely metallurgical problem, or rather problems. The object of their research was to ascertain the structure of electrolytic depositions of two metals simultaneously. They also describe investigations on the internal transformations of certain silver-zinc alloys, and alloys of copper and aluminium. Some account is also given of the X-ray analysis of cold-worked aluminium and of duralumin, and of their viscous deformation and recrystallisation. Some apology is offered for having embraced so many and so varied substances, but as the work was of a preliminary and tentative nature, it was conceived on broad general lines calculated to supply an answer to the question: "What may be expected of X-ray analysis on problems of general interest, and what are the practical results which may be anticipated from the adoption of the method?" The authors believe that their investigations supply answers to these questions.

Alloy Formation on Electrodeposition

THE results obtained have been the subject of a communication to the Académie des Sciences, and are briefly described in the article. A Coolidge tube was employed, the anticathode being molybdenum, as usual, water-cooled. A voltage of 40,000 was employed, and the substances subjected to the action of the resulting rays were a copper-zinc deposit, on steel; cadmium-silver on duralumin; cadmium-tin on duralumin; and cadmium-nickel on duralumin. It was, to begin with, sought to discover whether, in the circumstances of electrodeposition, these metals preserved their identity, or whether they combined with or alternatively, entered into mutual solution with one another. In the case of the silver-cadmium deposit, as in that of the others, the normal X-ray spectrum of each of the metals is plotted against that given by the deposit, and in the result it was found that the alloy consisted of two constituents, as the spectra of both metals were superimposed on one another. One of them had a crystal system identical with that of silver, but of different dimensions, probably indicating that the solid solution was rich in silver. In the case of the tin-cadmium deposits, two constituents were again detected, one of which was certainly tin, and the other a cadmium-rich solution, as its spectrum was that of cadmium, although the lines were slightly displaced. Finally, in the case of the nickel-cadmium deposit a spectrum was obtained differing entirely from that of either of the two constituent metals. The general conclusion is drawn that the simultaneous electrodeposition of two metals rarely results in the superimposition of one on the other, but usually in the formation of an alloy the spectrum of which differs, often considerably, from that of the constituent metals. Further investigations on this interesting subject are in progress.

Effect of Service on Endurance Properties of Rails

A PAINSTAKING and highly interesting investigation has been carried out by J. R. Freeman and H. N. Solakian, under the auspices of the Bureau of Standards, Washington, with the object of ascertaining the effect of service on the endurance properties of steel rails, and forms the subject of Research Paper No. 92 of the *Journal* of the Bureau. It was hoped, as the result of experiments on a number of specimens of steel rails used on the Baltimore and Ohio Railroad and on the Canadian Pacific Railway, to determine which of the two rival theories respecting the cause and mode of transverse-fissure failures was the more closely in agreement with the observed facts. The American rails had withstood well over 21,500,000 tons of traffic, and the Canadian rails from 12,130,000 to 17,305,000 tons, before being taken up. One view as to fatigue failures in steel rails is that the stresses developed under present-day service conditions exceed the endurance limit of present-day steels; the other is that if sound rail steel is subjected to repeated stress above its endurance limit, all rails in similar service will fail, ultimately, through transverse fissure, after similar periods of life. It was to settle this question, and also to investigate the influence of "stress-raisers," that the experiments were undertaken, as a settlement of the question

would influence wheel loads, and, conversely, the properties to be looked for in steel, the specifications for which it might be necessary to make even more strenuous than they are at present.

Cause of Fatigue Failures

THE results were inconclusive, but other hardly less important conclusions were arrived at. To begin with, the American rails, with the largest tonnage records, gave better results on fatigue testing than the Canadian rails. Moreover, in the case of the American rails, no evidence was found of any weakening by "overstressing," or strengthening by "understressing," in areas below the work-hardened layer of the rail-heads. The endurance properties were the same as before service, steel from the same heats as those from which the original rails were made having, in some of the experiments, been available for the purpose of making comparative tests. Hence, as regards the American rails, it was concluded that they had not been stressed beyond their endurance limit in service. The steel from the Canadian rails did, however, show in some cases an appreciably lower endurance limit than steel from new rails from the same ingot position and heat, although they had carried 60 per cent. less traffic than the Baltimore and Ohio rails. On the whole, the view that emerges is that transverse fissures develop from some defect initially present in the rail, which acts as a nucleus for a fatigue failure. This is, of course, the converse of the view that it is overstressing which initiates failure. If the official view is correct the next step is to search for and identify the nature of the "initial defects" occurring in rail steel, and to elaborate methods for their avoidance during the steel-making, casting and rolling processes.

Rationalisation and Amalgamation

IN the steel industry rationalisation and amalgamation are proceeding apace. Last month, it was announced that Guest, Keen and Nettlefolds, Ltd., and Baldwins, Ltd., subject to the preparation of a detailed scheme and to the necessary consents being obtained, had agreed to form a company to take over and operate as from January 1, 1930, the coke ovens, blast furnaces, steel works, and heavy steel rolling mills of the two companies. The agreement, which links up two of the leading concerns in the steel industry, constitutes an important step in the rationalisation of the steel industry. Rationalisation, it should be noted, may involve the segregation as well as the aggregtion of assets; in this instance, both processes are involved, and the economies both of specialisation and of co-ordination will doubtless result from the fusion without any loss of the advantages of association with two such powerful concerns as Guest, Keen and Nettlefolds and Baldwins, which both possess world-wide interests.

It is also believed that negotiations are proceeding between the iron and steel firm of Dorman, Long and Co., and the Furness group of companies, for working arrangements which will enable greater economy of production. The Furness group, so called in view of the fact that Viscount Furness is chairman of the companies concerned, embraces a number of important iron, coal, and steel undertakings, including Cargo Fleet Iron Co., the South Durham Steel and Iron Co., Weardale Steel Coal and Coke Co., and Broomhill Collieries. In November, 1928, the South Durham Co. acquired 95 per cent. of the share capital of the Cargo Fleet Co., thus strengthening the link which already existed between the two concerns. Dorman Long and Co. recently absorbed the undertaking of Bolckow, Vaughan, and Co., and should the above negotiations be brought to a satisfactory conclusion, practically the whole of the Tees-side iron and steel works will be brought into one huge combine.

Scottish Moves

THE widespread nature of the changes which are taking place in the steel industry is further emphasised by the official announcement just made by the two Scottish firms involved that Wm. Beardmore and Co., Ltd., of Parkhead Forge and Mossend Steelworks, have made an arrangement with David Colville and Sons, Ltd., whereby the latter firm acquire the goodwill of Beardmore's business in so far as it relates to plates, sections, and rails. The complete arrangement operates as from February 1. The agreement does not involve amalgamation, interchange of shares, or any form of merging, financial or otherwise.

As the result of this arrangement, 600 workers who are employed in the plate and sheet mills at Parkhead are thrown out of employment. The transfer of the work to the plants of David Colville will provide more employment at the Motherwell, Glengarnock, and Clyde Bridge Mills, but more "hands" will not be taken on at the works mentioned, as a full week is not operative meantime. The scheme, it is stated, is an effort to improve the efficiency of the steel trade on the Clyde in competition with other sources by enabling the firms concerned in the arrangement to specialise in those classes of work for which they are best fitted, and by putting the maximum volume of work into each firm to make that specialisation worth while. In other words, this arrangement will have the effect of reducing the cost of production in all the lines mentioned.

Beardmore's plant will concentrate on heavy forgings. Probably £100,000 will be expended by the Beardmore organisation on developments at the Parkhead works during the coming year. A commission of four experts has been on an extended tour of the steel plants in this country and on the Continent, and important undertakings have been inspected with a view to ascertaining the latest practice and improvements in technique which can be applied at Parkhead.

Tin Restriction Scheme

THE Tin Producers' Association announce that his Excellency Don Simon Patino, in view of the position of the tin-producing industry and his desire to promote its best interests, is not only desirous of co-operating with the Tin Producers' Association, but has given instructions to his engineers in Bolivia to take steps to give effect to the policy of the Association. It is further announced that his Excellency has accepted the invitation of the Council to become the Honorary President of the Association and to nominate two members to represent his interests on the council. Producers in Bolivia responsible for upwards of 80 per cent. of the output of that country now support the policy of the Association. As practically all the leading Malayan and Nigerian producers have agreed to accept the Council's recommendations, and the great majority of such producers are, in fact, already retarding their output in accordance with those plans, the way is now clear for the immediate adoption of a world-wide scheme of regulation. It is an essential condition of these recommendations that the output control shall only be enforced until the price of the metal attains a basis economical to the majority of the world's producers. Meanwhile, the Association is energetically pursuing a campaign of research for new and extended uses of tin.

Corrosion of Oil Storage Tanks

VALUABLE information bearing on the subject of the corrosion of oil storage tanks, a matter of vital interest to the petroleum industry, is being obtained in the course of an investigation being conducted near Borger, Texas, by the Petroleum Experiment Station of the United States Bureau of Mines, Department of Commerce, Bartlesville, Oklahoma, and the State of Oklahoma. This investigation is being conducted in co-operation with the Gulf Oil Co., the Parkersburg Rib and Reel Co., and the Aluminum Co. of America. The great interest manifested by the petroleum industries in the subject of oil tank corrosion is probably due to several causes; first, the development of fields in which high-sulphur petroleum and hydrogen sulphide-bearing gases are being produced, and second, the use of vapour-tight tanks, as corrosion often takes place to such an extent that vapour-tanks become leaky. The tank battery upon which the observations are being made is located about two miles north of Borger, on a lease belonging to the Gulf Oil Co. The battery consists of one 500 barrel all-aluminium flow tank, two 250 barrel all-aluminium stock tanks, and two 250 barrel all-steel stock tanks.

To carry on this investigation, a fully equipped laboratory for making water analyses, photomicrographs, gas analyses, and various sulphur determinations for water, oil, and gas has been established on the lease. In addition to the various chemical determinations, many observations are continually made on the tank battery itself. Each tank is equipped with ten thermocouples located at various strategic points, the temperatures being determined at regular intervals with a potentiometer. Each tank is also equipped with mercury-actuated recording thermometers.

Trade, Commerce, Finance: The Month in Review

From Our Market Correspondent

It cannot be said in the iron and steel trade that the opening of the year has been one of promise: it has not responded to those fervent hopes for better times which find general expression at the commencement of each year. Trade conditions in the closing months of 1929 had a tendency to dullness, they were certainly not so good as in the earlier part of the year. And now, having completed the first month of 1930, it is disappointing to find that there is no improvement at all. There has been no increase in business activity, orders are by no means plentiful, and as a result competition is increasingly severe.

There is a kind of empty satisfaction in being able to attribute a decline in trade to definite causes, even if those causes cannot be speedily removed; and in the present instance it is not difficult to put forth explanations of this slackness in trade, a slackness which is not confined to the iron and steel section but seems to have affected nearly all industries.

Influences

There are several influences which have combined to create a sense of a lack of confidence. The burdens of taxation are not likely to be lessened; indeed, to meet the cost of the new Government measures, more money will have to be raised in taxes, which means less for industry. The uncompromising attitude of the Government towards the safeguarding duties is causing much apprehension in certain sections of industry, particularly in the motor trade, which is such a large customer of the steel works. Further, the sensational financial crashes which have disturbed the City during the past few months have seriously shaken confidence in financial and trade circles, and the somewhat frightened temper which has been created is a hindrance to trade expansion.

One does hear in some quarters the opinion that confidence is slowly returning, but it needs a strong optimism to look for any real improvement on present conditions in the immediate future. We are in a period of great financial and industrial difficulty, of which the steel trade has its full share, and the way out is not yet clear.

Possible Remedies

The conditions described have naturally focussed attention on the possible remedies, and once more the cry for rationalisation is very strong, particularly from the expert accountants who have been called in to straighten out the chaos in so many industries. In some cases, the advice has been acted upon, but not to the full extent implied in the term. This partial adoption of rationalisation is causing some uneasiness in the minds of the experts who advocate it, and already they are calling attention to the dangers attendant on incomplete schemes.

But rationalisation carried out to the full is very ruthless and requires great courage, and industrial psychology in this country is hardly sufficiently advanced for it. Nevertheless, it does seem to be the only effective way of dealing with the serious problem of excess productive capacity. There is one aspect of this matter which hardly receives the attention it deserves, and that is the human element. The mental make-up of the employees and the staffs has an important bearing on the results produced, and needs careful consideration. However, that is a point which cannot be discussed here.

Recent Amalgamations

There have been several recent amalgamations in the steel trade to which the term rationalisation has been applied. Among them are the English Steel Corporation, which took over certain interests of Vickers, Cammell Lairds and Armstrong Whitworths. They are now closing down some of the surplus plants in the Sheffield and North-East Coast districts. Another instance is the Dorman-Bolckow Vaughan fusion on the North-East Coast. It remains to be seen how far they intend to go in the reduction of plants and staffs.

The latest example is the combination of the steel-producing departments of Baldwins and Guest Keens in South Wales. Notwithstanding the huge profits shown year by year by Guest Keens, their steel works have not been a remunerative unit, while Baldwins have been very severely hit by the depression. This combination, if carried through on the right lines, may help to restore some of their former prosperity to those works.

Price Movements

There have been some interesting price movements recently. Shortly before Christmas, the Steel Associations decided to revise the prices of the various controlled materials. The price of plates was adjusted so as to bring the various districts more into line with each other. The basis can still be regarded as £8 17s. 6d., with slight variations to suit the local conditions of the different areas. In the Southern area, the price is £9, while on the North-East Coast it is £8 15s. Sections have been advanced 5s. per ton, making the basis price £8 7s. 6d., and joists have been advanced to £8 10s. basis, which is 7s. 6d. increase. No alteration was made in the rebate to be allowed from these prices, so that they represent a slightly increased income to the steel works. Export prices have also been advanced, plates 2s. 6d. per ton and sections and joists 5s. per ton.

While the controlled materials are thus to show a better return to the steel makers, the uncontrolled materials, such as small bars and boiler plates, present another picture. The competition in these items is keener than ever. For small steel bars there has been no advance; in fact, in some cases the price has been reduced. This particular competition is thrown into sharp relief when one compares the two sets of prices. For round bars 3 in. and up, which are controlled by the Associations, the basis price is £9 7s. 6d. For bars under 3 in., which are not controlled, prices ranging from £7 17s. 6d. to £8 10s. are freely quoted, not only by re-rollers but also by the steel makers themselves. It is difficult to see why a bar, say, 2 in. round, which takes longer to roll than a 3-in. bar, should be sold at 20s. per ton less.

Intense Competition

The reason is to be found in the intense competition amongst the steel makers and the re-rollers, due to the shortage of orders. The absurdity of this position is being slowly forced to the notice of those responsible for it, and there are signs that more sensible counsels are likely to prevail. Boiler plates also are keenly competed for, and a recent attempt to stabilise the price failed. The margin between the prices of these and of ordinary plates, ranging from 12s. 6d. to 20s. per ton, offers too attractive a scope for competition at a time when plate mills generally are short of orders.

The pig iron market has been very quiet during the month; in fact, conditions are hardly as favourable as they were before the Christmas holidays. There is little tendency to buy forward, purchases being restricted as far as possible. In the Midlands, this may be due to the desire to wait for the result of the pig iron producers' meeting at the end of the month. Prices are not then likely to be increased, but a reduction is equally unlikely, although coke can now be bought more cheaply. The hematite market is also very quiet.

Nothing better can be said about the various sections of the steel market. New orders are not coming in fast enough to replace the output. Billets are about the best feature, and most of the works have a fairly good order book for these, a position which may be due to some extent to the unsatisfactory condition of this particular market on the Continent. Some confusion has been caused there by the efforts to fix prices, and for the moment several of the foreign works are not quoting for export. The small steel bar trade is much quieter than it was a month or two ago, largely owing to the seasonal slackness in the motor trade. Generally speaking, the state of trade is not too bright, and is causing some anxiety to the steel makers.

The number of blast furnaces in operation at the end of December was 162, one less than in the previous month. The output of pig iron was 643,000 tons, compared with 631,400 tons in November. The output of steel amounted to 661,200 tons, compared with 815,000 tons in November. The Christmas holidays account for the large difference.

Some Inventions of the Month

By Our Patents Correspondent

Abstracts of other Patents of metallurgical interest will be found in our Patent Literature, published weekly in THE CHEMICAL AGE.

Alloys

ALUMINIUM steel is made by the addition of an alloy containing 40 per cent. of iron and 60 per cent. of aluminium to molten steel. To obtain this alloy, a bath of cast iron or steel is first deoxidised with aluminium or silicon and thereafter the required amount of fused aluminium added. If aluminium is the deoxidant, the amount used for that purpose is just sufficient to prevent the formation of a scum on adding the bulk of the aluminium later. See Specification 321,936 (Dicker), dated August 14, 1928, a communication from Soc. Aubert et Duval Frères, of Paris.

A PROCESS for producing iron-chromium alloys by adding alternately to a bath of molten iron layers of lime and layers of briquettes comprising chrome ore and ferro-silicon is described in Specification 322,189, dated August 28, 1928, by H. G. Flodin, of Stockholm, Sweden. An iron bath of low carbon content is first formed in the furnace from briquettes of iron ore, carbonaceous reducing agent, and a binder. The whole of the charge may be fed to the furnace by a worm conveyer from the bottom of a single shaft, or the iron ore may be fed through one shaft and the chrome ore and lime through a second shaft, the furnace gases having access only to the iron ore shaft. The amount of lime is sufficient to form a liquid slag on the surface of the bath.

INVENTIONS relating to the preparation of alloys are described in Specifications 322,216–7, dated August 30, 1928, by W. P. Digby, of London.

According to Specification 322,216, alloys are obtained comprising 20·5-34·5 per cent. of iron, 21-50 per cent. of nickel, and the remainder copper, with or without up to 20 per cent. of chromium replacing a corresponding amount of iron. The constituents may be melted and the product finished in an induction furnace or the preliminary melting may be effected in a gas-, coke- or oil-fired furnace. A small quantity of manganese may be added five minutes before pouring, and a deoxidant such as magnesium immediately before pouring.

According to Specification 322,217, the transference from the crucible of the gas-, coke-, or oil-fired furnace to the induction furnace is effected after about three-quarters of the total alloying period has elapsed. Fluxes such as magnesium chloride or calcium chloride may be used. The method of preparation, which is applicable to alloys in general and to iron-copper and iron-copper-nickel alloys in particular, ensures an even distribution of the constituents in the products.

Annealing and Pickling Metals

METAL to be coated with metals other than tin is subjected to a preliminary cleaning and annealing by immersion at annealing temperature in a pickling bath to which has been added an amount not exceeding 25 per cent. by volume of a cyanide of an alkali metal. The annealing temperature may range from 500° C. to 1200° C., and suitable compositions of baths for annealing at various temperatures are specified. See Specification 321,643, dated August 3, 1928, by W. Hanby, of London.

Coating with Chromium

A PROCESS for coating metallic or non-metallic bodies with chromium by heating to incandescence in an atmosphere containing an iodide of chromium is described in Specification 321,914 (Dicker), dated July 9, 1928, a communication from Naamlooze Vennootschap Philips' Gloeilampenfabrieken, of Eindhoven, Holland. A ductile chromium is produced if the atmosphere is free from silicon and like impurities. In one arrangement, a tungsten wire is suspended within an evacuated vessel heated to 800—1000° C., and a chromium iodide or a mixture of chromium and iodine is admitted into the vessel. In another arrangement a core-body to be coated is heated within a vessel containing some iodine and a second core-body previously coated with chromium. The process is specially suitable for producing electric resistance wires and cathodes for electronic discharge tubes.

Electrolytic Processes

RAPID electrolytic deposition of copper is effected by raising the temperature of the bath, *e.g.* to 40° C., and introducing finely distributed gases continuously or intermittently. The gases, preferably air or other oxidising gases capable of combining with the gas liberated at the cathode, may be introduced through clay cells, cane, or other porous bodies. An envelope of felt or like material assuming an open texture when immersed may be arranged around the cathode to prevent the passage of solid particles. See Specification 322,371, dated December 28, 1928, by K. Breusing and U. Gottesmann, of Berlin.

Metal Powders

PROCESSES for the production and treatment of metal powders are described in Specifications 322,039 (Johnson), dated September 28, 1928, and 322,082 (Johnson), dated November 17, 1928, communications from I.G. Farbenindustrie Akt.-Ges., of Frankfort-on-Main, Germany.

According to Specification 322,039, the light and spongy or pulverulent metals obtained by the thermal decomposition of metal carbonyls are converted into heavy powders by comminuting them, preferably in an inert or reducing atmosphere. Thus an extremely fine powder weighing 4,300 grammes per litre is obtained from iron carbonyl by decomposition at 320° C. and subsequent grinding in a ball mill in an atmosphere of nitrogen.

According to Specification 322,082, metal powders are freed from impurities which form volatile compounds with oxygen by subjecting them to oxidation with agents yielding sufficient oxygen to produce only the volatile oxygen compounds of the impurities, and thereafter heating to remove such compounds by volatilisation. Oxygen, air, carbon dioxide, and water are specified for effecting the oxidation, and the volatilisation may be effected at about 500° C. in an inert or reducing gas, or at such a temperature, and with simultaneous or subsequent application of pressure if desired, that the powder sinters to form porous or non-porous articles. In an example illustrating the production of the metal powder, the oxidation of the impurities, and the removal of the volatile compounds, all in one operation, an oxidising gas is introduced into a vessel in which iron carbonyl is being decomposed, and the oxidised iron powder produced is allowed to fall through a heated tube or into a bath of molten iron.

Reducing Copper Ores

A PROCESS for reducing copper-bearing ores, especially such as contain iron pyrites, is described in Specification 321,685, dated August 15, 1928, by F. L. Duffield, of London. The ores, after concentration and in some cases after a preliminary roasting, are mixed with carbon, and if necessary with lime or limestone, and reduced in a furnace by raising the charge through progressively hotter zones so that the reduction is effected at a temperature below the melting-point of the metal and the reduced metal is discharged at the top. The product may then be subjected to magnetic separation, the iron obtained being briquetted and used for the production of soft iron or steel by subsequent melting or for precipitating copper from solution. The apparatus used is that described in Specification 304,174 (see THE CHEMICAL AGE, Vol. XX, p. 23 [Metallurgical Section]). Zinc and other volatile metals may be recovered as described in Specification 310,362.

Steel Inquiry

IT will be at least a month, it is anticipated, before the Civil Research Committee which is inquiring into the iron and steel industry, under the chairmanship of Lord Sankey (Lord Chancellor), will be in a position to present a report. Meanwhile the Committee are awaiting the report of the mission which has been sent to the Continent with the object of furnishing the Committee with reliable data on the comparative cost of labour between Great Britain and her Continental rivals. The mission of three consists of representatives of the iron and steel workers, the employers, and the Board of Trade.

Current Articles Worth Noting

We give below a brief index to current articles in the technical Press dealing with metallurgical subjects.

ALLOYS.—The velocity of dissolution of zinc-tin alloys in acids. R. Vondracek. *Collection Czechoslovak Chem. Communications*, December (1929), pp. 627–637 (in English). The velocity of solution usually increases at the beginning and then decreases. The general behaviour depends on chemical and physical conditions and mechanical influences.

Variations in the hardness of certain metals and alloys as a function of cold-hardening. Guichard, Clausmann and Billon. *Comptes Rendus*, January 13, pp. 112–114 (in French).

Light alloys. Z. Jeffries. *Metals and Alloys*, December, pp. 267–271. Deals with aluminium and magnesium alloys, giving compositions and physical, mechanical and chemical properties.

The X-ray determination of the limits of mixed crystal formation of silver-copper alloys. O. Weinbaum. *Zeitschrift Metallkunde*, December, pp. 397–405 (in German).

A study of copper-aluminium alloys containing manganese, tin and cobalt. E. Morlet. *Revue de Métallurgie*, September, pp. 464–487; October, pp. 554–569; November (1929), pp. 593–605 (in French).

BRASS.—The effect of third metals on the constitution of brass alloys. II.—The effect of nickel. O. Bauer and M. Hansen. *Zeitschrift Metallkunde*, November, pp. 357–367; December, pp. 406–411 (in German).

GENERAL.—The work of the metallurgist on the Witwatersrand. G. H. Stanley. *Journ. Chem., Met. and Mining Soc. of S. Africa*, November (1929), pp. 158–163.

Intermetallic compounds in mercury. A. S. Russell. *Nature*, January 18, p. 89.

Some reactions of nickel carbide, Ni_3C, prepared at low temperatures. H. A. Bahr and T. Bahr. *Berichte*, January 8, pp. 99–102 (in German).

The preparation and properties of the borides of tantalum and columbium. L. Andrieux. *Comptes Rendus*, December 30, pp. 1279–1281 (im French).

The X-ray analysis of the system nickel-bismuth, G. Hägg and G. Funke. *Zeitschrift physikalische Chem.* Vol. 6, Part 4, pp. 272–283 (in German). X-ray and microscopic investigation have shown the existence of two intermediate phases in the system. The phase poorer in bismuth possesses the nickel arsenide structure and its domain of homogeneity apparently lies at bismuth contents somewhat below 50 atomic per cent. The structure of the phase richer in bismuth could not be determined. It contains about 75 atomic per cent. of bismuth.

Preparation of microsections of tungsten carbide. S. L. Hoyt. *Trans. Amer. Soc. Steel Treating*, January, pp. 54–58.

IRON.—Pyrophoric iron. I.—Preparation and properties. T. G. Finzel. *Journ. Amer. Chem. Soc.*, January, pp. 142–149. Pyrophoric iron can best be prepared by reducing precipitated ferric oxide (from ferric nitrate) by hydrogen at 500°C.

The density of some alloys of iron in the liquid state. C. Benedicks. *Comptes Rendus*, January 13, pp. 114–116 (in French).

Nickel and chromium extend the field of iron castings. F. B. Coyle. *Metals and Alloys*, December, pp. 272–275.

PASSIVITY.—The theory of passivity phenomena. VII.—The anodic behaviour of copper in electrolytes containing sulphuric acid. W. J. Müller and L. Holleck. VIII.—The anodic behaviour of zinc in electrolytes containing sulphuric acid. W. Müller and L. Holleck. IX.—The passivity of lead in sulphuric acid, with a note on the theory of the formation of lead anodes. W. J. Müller and K. Konopicky. X.—The time law of auto-passivation. W. J. Müller and K. Konopicky. XI.—The anodic behaviour and the passivity of iron in sodium sulphate solutions. W. J. Müller and W. Machu. *Monatshefte*, Vol. 52, Part 6, pp. 409–424, 425–441, 442–462, 463–473, 474–492 (in German).

RHODIUM.—Melting, mechanical working and some physical properties of rhodium. W. H. Swanger. *Metals and Alloys*, December, pp. 263–267.

STEEL.—Steel inspection standards for roller bearings. A. S. Jameson. *Transactions Amer. Soc. Steel Treating*, December, pp. 937–949.

Steel crystals. J. S. G. Primrose. *Journ. West of Scotland Iron and Steel Institute*, October, pp. 13–14.

The slags produced in steel making: Their effects on the product and on the process itself. G. A. Dornin. *Trans. Amer. Soc. Steel Treating*, January, pp. 59–80.

A microscopic study of improperly heated forgings. A. S. Jameson. *Trans. Amer. Soc. Steel Treating*, January, pp. 80–89. Discusses the defects arising from the uncontrolled heating of steel prior to hot working or forging.

TESTING.—Physical testing methods and apparatus. E. A. Allcutt. *Canadian Chem. and Met.*, December, pp. 329–331.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

Mortgages and Charges

[*NOTE.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case, the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.*]

BALKAN MINERAL DEVELOPMENT CO., LTD., London, E.C.—Registered January 3, series of £7,500 debentures, present issue £3,000; general charge; also registered January 3, £6,000 debenture, to Northern Mines, Ltd., 12, Kirby Street, E.C.; general charge. *Nil. December 31, 1928.

BEARDMORE (WILLIAM) AND CO., LTD., London, S.W., steel manufacturers.—Registered January 10, £738,337 A income debenture stock secured by Trust Deed dated January7, 1930, and a disposition supplemental thereto dated January 9, 1930; charged on properties, shares, etc., comprised in schedules filed with the particulars, also general charge, except certain shares (subject, etc.). *£1,696,804. November 14, 1929.

HARRIS (F. W.) (BIRMINGHAM), LTD., metal merchants.—Registered January 2, £30,000 debentures; general charge. *£10,000 debentures. March 11, 1929.

ITABIRA IRON ORE CO., LTD., London, E.C.—Registered December 23 £7,500 further charge (supplemental to mortgage dated March 2, 1916 and other deeds), to Brazilian Investment Syndicate, Ltd., 5 Fenchurch Street, E.C.; charged on premises charged by said mortgage. *£641,751. December 31, 1928.

LAGARES TIN MINES, LTD., London, E.C.—Registered December 31, series of £37,500 (not exceeding) debentures present issue £30,000; charged on certain shares, etc., also general charge. *Nil. April 3, 1929.

MOSS AND GAMBLE BROTHERS, LTD., Sheffield steel manufacturers.—Registered December 20, £5,000 debentures; general charge (subject, etc.) *£9,000. January 1, 1929.

UGANDA TIN FIELDS, LTD., London, E.C.—Registered December 19, debenture to Hill Trust, Ltd., 21, Great Winchester Street, E.C., securing all moneys which may be advanced; general charge. *Nil. May 24, 1929.

WHEAL REETH TIN, LTD., London, E.C.—Registered December 16, £4,700 debentures, part of £12,500; general charge. *Nil. January 11, 1929.

Satisfactions

BWANA M'KUBWA COPPER MINING CO., LTD., London, E.C.—Satisfaction registered December 17, £2,110, part of amount registered April 13, 1928.

BOLCKOW VAUGHAN AND CO., LTD., Middlesbrough, ironmasters.—Satisfactions registered January 3, £226,550, part of amount registered December 23, 1920, and £20,000, registered March 19, 1926.

Monthly Metallurgical Section

Published in the first issue of "The Chemical Age" each month.

NOTICE.—Communications relating to editorial matter for our Monthly Metallurgical Section should be addressed to the Editor, THE CHEMICAL AGE, Bouverie House, 154, Fleet Street, London, E.C.4. Communications relating to advertisements and other business should be addressed to the Manager. Contributions will be welcomed from correspondents on any points of interest to metallurgists bearing on works practice or current research problems.

Commercial Uses and Production Costs of Beryllium

The following interesting details respecting the production costs of beryllium, its possible uses as a constructional material or for incorporation in certain alloys, and the characteristics and sources of beryl, the ore from which beryllium is obtained, are based on a recent American investigation, and are taken from Information Circular 6190, "Beryllium and Beryl," copies of which may be obtained from the United States Bureau of Mines, Department of Commerce, Washington, D.C., U.S.A.

THE commercial application of beryllium, a metal of great interest on account of its combined lightness and strength, must be severely limited until the cost of extraction, now almost prohibitively high, can be reduced. Beryllium is quoted in the United States at $200 per lb. and shipments are made chiefly from small stocks manufactured in 1927 or earlier. As in all metallurgical operations, the production of the metal on a laboratory or semi-commercial scale is much more costly than it would be in large lots. The metal, it is estimated, could be manufactured at greatly reduced costs, with the market absorbing appreciable tonnages annually.

Beryllium, or glucinum as it is also called, is often listed as a rare element, though it probably is more abundant in the earth's crust than many of the minor metals that are ordinarily considered rather common. It is not a new metal, for it has been known for more than a hundred years, but even yet it has not been used commercially except to an extremely limited extent. Since beryllium is very light and exceptionally hard and strong, many believe that it is destined to share with or even to exceed magnesium and aluminium in the fast-growing demands for light metals to be used in the construction of aircraft and other suitable purposes.

The mineral beryl, which seldom contains more than about 5 per cent. of the element, is the only recognized ore of beryllium. It is a common accessory in pegmatite veins and is also found in clay slate and mica schist, but hitherto only the gem varieties, including emerald and aquamarine, have been actively sought. In several localities, however, ordinary beryl is produced as a by-product in mining mica and feldspar, and often beryl has accumulated on the dumps because no buyer could be found. Only within the last two or three years has there been an active demand for the mineral, even in ton lots, and as yet requests for carload shipments are extremely rare. Considerable interest has been awakened, nevertheless, in the possibility of opening deposits that will yield beryl in substantial quantity.

Characteristics and Uses

The metal beryllium has aroused the interest of many investigators, who have worked out various processes of extracting it from its ores. Beryllium is very light, having about the same specific gravity as magnesium, and is almost as hard as quartz. It will scratch glass and it takes a high polish. Early investigators claimed that beryllium was malleable and could be easily forged and cold-rolled into sheets, but later studies do not support these claims. While it is possible that absolutely pure beryllium, if obtained, might have the qualities formerly attributed to it, investigations conducted at the Bureau of Standards with metal of 98·7 per cent. purity indicated the contrary. This product was described as "coarsely crystalline, reminding one of antimony or bismuth . . . hard and brittle, and apparently incapable of being wrought cold." It is further stated that more recently metal of more than 99·5 per cent. purity has been produced, some lots of which are semi-malleable cold and can be rolled hot into a thin sheet. The melting point of beryllium has been determined as 1,285° C., or a little above that of manganese.

Considerable research has been carried on in the United States and other countries into the possible applications of beryllium, but the use of the metal is still in the experimental state. From time to time it has been described as the ideal light metal for aviation use, and the Materials Sub-committee of the U.S.A. National Advisory Committee for Aeronautics is arranging for tests of beryllium for use in aircraft construction. Nevertheless, to date, this use has not materialised, and a German company, which has been particularly diligent in its studies of the properties and possible uses of the metal, has concentrated its efforts chiefly upon alloys containing small quantities of beryllium with heavier metals, such as iron, copper, and nickel.

Beryllium Alloys and Glasses

It is claimed that beryllium hardens iron to a great extent, and that alloys of beryllium with copper and nickel have high resistance properties and should find application in grinding, stamping, spring making, etc.

In the United States the metal has been produced on a semi-commercial scale by one concern. While this company has devoted some attention to the heavy alloys, chiefly those of beryllium with gold and silver, its chief interest has been with the beryllium-aluminium alloys. It has been stated that the addition of beryllium to aluminium increases its strength and resistance to corrosion, and that an alloy containing 70 per cent. beryllium and 30 per cent. aluminium exhibits materially greater resistance to salt water and air corrosion than any other of the light alloys. Beryllium has been used in the United States and abroad in X-ray apparatus. Another use which may grow considerably is for electrodes in connection with neon signs.

Experiments have been conducted at the University of Pittsburgh on over 80 different glasses in which beryllium oxide replaced calcium oxide or magnesium oxide. It was found that beryllium glasses are somewhat more refractory than magnesium or calcium glasses and that beryllium glass is much harder than calcium or magnesium glass. Results so far obtained indicate that beryllium glasses warrant further study.

Beryl, the Beryllium Ore

Beryl, the only recognised ore of beryllium, is a compound silicate of aluminium and beryllium. In colour, beryl varies from white or colourless to green, blue, yellow (amber), and even red, but usually it is some shade of green. Clear transparent crystals are cut as gems. The deep green variety, the colour of which is attributed to the presence of a little chromium, is the emerald. Aquamarine, a sky-blue or greenish-blue variety, is also a precious stone.

Beryl is about as heavy as quartz, sometimes a little heavier, but its outstanding characteristic is its hardness. It is harder than quartz or tourmaline and practically as hard as topaz, from which it differs in that it has no distinct cleavage. It crystallizes in hexagonal prisms ranging in size from mere thread-like pieces to huge crystals many feet in length and weighing several tons. Occasionally it occurs in large columnar or granular masses.

In addition to its potential value as a source of beryllium metal, ordinary beryl may have other uses, notably as a substitute for feldspar in the manufacture of porcelain.

Occurrences of beryl have been noted in many American States. Good emeralds have been found in Massachusetts and in North Carolina. Aquamarines and other gem specimens have been obtained at Paris and Stoneham, Me., Mount Antero, Colo., and several places in North Carolina. The best emeralds, however, are mostly imported. The world supply comes from Colombia, British India, Brazil, Siberia, Australia, and (recently) South Africa. In recent months there has been some inquiry for beryl from abroad, and it is understood that foreign buyers have been paying in the neighbourhood of $60 a short ton f.o.b. New York. However, there cannot be said to be a regular market price for beryl, and sales are probably a matter of bargaining.

The Form of Copper in Converter Slag

By F. S. Wartman and W. T. Boyer

The full paper from which the following extracts are taken is one of a series reporting the results of an investigation conducted by the South-West Experiment Station of the U.S. Bureau of Mines, in co-operation with the University of Arizona, on the general subject of losses in copper smelting. It is reprinted from U.S. Bureau of Mines Report of Investigations 2985. Mr. Wartman is an assistant metallurgist and Mr. Boyer a Research Fellow of the U.S. Bureau of Mines, South-west Experiment Station.

RECENT changes in metallurgical practice, particularly those in flotation, have altered greatly the functions of the different units of a copper smelter. Gangue minerals are removed from the feed so much more thoroughly that the reverberatory furnace, once virtually a concentrator in which a low-grade ore was concentrated into a rich matte by virtue of the removal of gangue elements as slag, has become very largely a melting furnace in which the rich flotation concentrates are rendered molten so that they may be converted. Moreover, since the proportion of matte to slag in the reverberatory furnace output is greater than it was formerly, the amount of converter slag returned to the reverberatory for cleaning is, in comparison to the amount of slag actually formed in that furnace, also much larger. In some cases, approximately half of the reverberatory dump slag may have originated in the converter.

The increase in the proportion of converter slag to total slag produced has brought about certain consequences not entirely desirable. Converter slags contain a high percentage of iron and therefore are high in specific gravity and are very basic. A considerable quantity of magnetite, both dissolved and suspended as solid crystals, is always a component. The basic nature of the ordinary converter slag and the presence of the suspended magnetite crystals make impossible the reduction of the copper content of the slag below approximately 1 per cent. by even the most prolonged settling, and a re-treating process is necessary. At present, general practice in western copper smelters is to return the converter slag molten to the reverberatory furnace. Here dilution by mixing with slag formed in the reverberatory furnace and reaction with raw sulphides and siliceous materials in the reverberatory feed reduce the magnetite and increase the silicates to the point necessary for a satisfactory dump slag.

Formation of Layers

This method of re-treating converter slag, although very simple, does not always go so smoothly as this brief description would indicate. After entering the reverberatory bath, converter slag, because of its greater density, often shows a tendency to form a more or less distinct layer immediately above the matte. Such a layer, mushy in consistency because of suspended crystals, interferes with proper furnace operation. It hinders the matte newly formed in the smelting zone from settling out of the slag; the extremely basic character makes for greater corrosion of the side walls of the furnace at the point where matte and slag meet; the suspended magnetite, in the case of furnaces producing a low-grade matte, may sink through the matte and gradually deposit a layer of crystalline magnetite on the bottom of the furnace. The growth of such a layer tends to become more and more rapid.

An economically and technically feasible mechanical method of re-treating converter slag would, by avoiding these difficulties, make possible greater furnace capacity, a more siliceous slag, a cleaner slag, and less corrosion of the furnace side walls. However, in order to judge correctly as to the feasibility of various possible methods of cleaning converter slag, one must first know the chemical and physical state of the copper content of the slag. This investigation was undertaken in an attempt to obtain information on these points.

The Points in Review

It is evident that neither microscopic nor chemical methods will distinguish conclusively the amounts of copper sulphide, copper oxide, and metallic copper present in a slag, although one may obtain an approximate value through consideration of the results of the different methods and the errors characteristic of each.

Such consideration leads to the conclusion that in slags produced in the converting of low or medium-grade matte the copper content of the first skimmings is in the metallic and sulphide form; the content of oxidised copper is so low as to be within the limit of error of the analytical methods available. There is, however, definite evidence of an appreciable oxide content in the later skimmings.

This conclusion is contrary to that attained by some investigators, who have argued that because of an ever-present excess of matte, and because of the completeness of the reaction between cuprous sulphide and cuprous oxide at furnace temperatures, it would be impossible for cuprous oxide to exist.

Equilibrium data as presented by Stubbs* are given in Table 1. A glance at these data will show that pure cuprous oxide and pure cuprous sulphide could not co-exist as separate phases in equilibrium under the conditions obtaining in a converter. However, the application of such data to the process of copper smelting is not so simple as this.

Table 1.—Equilibrium pressures of sulphur dioxide over mixtures of solid copper, cuprous sulphide and cuprous oxide at various temperatures.

Temperature °C.	Equilibrium pressure of SO_2, in cm. Hg.
614	16·6
662	33·2
722	67·8
730	76·5
726·5	69·0
768	110·3
810·5	164·9
851·5	230·4
893	305·2
931·5	377·0
973·5	435·5
1,012·5	476·5
1,051·5	491·0

In the first place, the operation of converting is not carried out under equilibrium conditions. This may be realised

* Stubbs, C. M., "The Action of Sulphur Dioxide on Copper at High Temperatures." *Jour. Chem. Soc.*, Vol. 103, 1913, p. 1458.

easily when one remembers that the gases emerging from the converter vessel contain several per cent. of oxygen ; under equilibrium conditions these gases would contain oxygen in a proportion so small as to be undetected by any ordinary method of analysis. Another fact indicative of this lack of equilibrium is that so far it has been found impossible to remelt converter slag, even when contained in pure magnesia crucibles and in an atmosphere of highly purified nitrogen, without producing a decided change of composition. Remelting is always accompanied by the evolution of sulphur dioxide gas and an increased proportion of copper content in the metallic form.

Secondly, these equilibrium studies of the reaction between cuprous oxide and cuprous sulphide have always been made with pure materials. Such results should not be applied to converter practice without due allowance for the fact that any copper oxide present during the operation of the converter is probably in solution in the slag. Cuprous oxide in such solution would be much less reactive than cuprous oxide in a pure separate phase. It is quite possible that such dissolved cuprous oxide would be precipitated from solution when the slag solidified, but it does not seem reasonable that such precipitated particles, securely embedded in solid slag, could react to any great extent with the matte prills scattered here and there through the slag.

In the third place, it can be shown that the presence of oxidised copper in the slags formed later in the blow is in no way inconsistent with equilibrium data available. Metallic copper, saturated with cuprous sulphide, is always found in slags skimmed near the white metal stage. Stubbs has shown that such molten copper dissolves sulphur dioxide gas, and that a substantial portion of the gas so dissolved reacts with the copper thus :—

$$SO_2 + 6\ Cu \rightarrow 2\ Cu_2O + Cu_2S.$$

In other words, whenever molten copper is in contact with an atmosphere containing sulphur dioxide, the molten copper will have in solution a certain amount of cuprous oxide. Also since cuprous oxide is soluble in molten ferrous silicate slag, any slag in contact with that molten copper must likewise, under equilibrium conditions, contain in solution some cuprous oxide. The exact amount would be determined by the distribution ratio for cuprous oxide between molten copper and slag. Exact calculation is not possible because the solubility of sulphur dioxide in copper at converter temperatures (1,250-1,300° C.) and the distribution coefficient for cuprous oxide between slag and copper are both unknown. Nevertheless, it is evident that the presence of an appreciable oxidised copper content in the later skimmings is not impossible.

General Conclusions

1. Chilled or quickly cooled converter slag is difficult to grind and the copper-bearing compounds are so finely disseminated that they are not freed by grinding through 200 mesh.

2. Slowly cooled or crystallised converter slag is much easier to grind than chilled slag and the copper-bearing compounds are segregated in granules of such size that they are largely freed from the slag by grinding them through 150 mesh.

3. Neither silver nitrate, sulphurous acid, nor a mixture of sulphurous, hydrofluoric and pyrogallic acids will distinguish between prill and dissolved copper, or between sulphide and oxide copper in the slag with an accuracy greater than 10 per cent. of the total copper content of the slag.

4. The copper content of the first slag skimmings from the converting of low or medium-grade matte is in the form of sulphide or metallic copper. Slags skimmed near the white metal stage may contain an appreciable proportion of the copper content in the oxidised form. The whole body of the slag produced in converting a matte containing 30 per cent. copper will have about 90 per cent. of the copper content in the metallic or sulphide form.

5. Since slowly-cooled converter slag produced from the converting of low or medium-grade mattes is easily ground, since the copper-bearing compounds are largely freed by grinding through 150 mesh, and since the copper content is approximately 90 per cent. in the sulphide or metallic form, it is believed that the cleaning of this type of slag by the flotation process is technically feasible.

Determining Iron Oxide in Liquid Steel

A New Method

AT the present time there are two generally accepted methods of determining iron oxide or oxygen in steel. The first, and older, is reduction of the sample with hydrogen, the water vapour formed being weighed and calculated back as per cent. oxygen in the steel. This was first devised by Ledebur some 50 years ago and held the attention of chemists and metallurgists during that period. The vacuum fusion method for determining oxygen in steel has been in vogue for the past few years, this method determining not only ferrous oxide but presumably all the other oxides. Both these methods deal with the oxygen content of solid steel and are applicable to steels in the cast or rolled conditions, but not necessarily to steels in the liquid state, since oxygen in the form of carbon monoxide or carbon dioxide is lost during solidification of the test piece or ingot.

Excess of Aluminium

The Metallurgical Section of the Pittsburgh Experiment Station of the U.S. Bureau of Mines, in co-operation with the Carnegie Institute of Technology and the Metallurgical Advisory Board, has devised a method for the determination of ferrous oxide in liquid steel. This consists briefly in killing a sample of liquid steel with an excess of aluminium and determining the alumina formed. The killing of the sample is done with heavy aluminium wire in the test spoon and not in the test mould. If the sample is killed in the test mould, oxygen may be lost at the first moment of solidification or the aluminium may segregate very badly in the test piece. On the other hand, when the aluminium is added to the liquid steel in the test spoon, fairly uniform distribution of alumina in the test piece is assured. A 1 per cent. aluminium addition has been found to give satisfactory results in the determination of the oxygen present. The manipulation is very simple, the aluminium being added to the test spoon as soon as the sample is withdrawn from the wicket hole of the furnace and the metal then immediately poured into the test mould. The solid sample is drilled and 20 grams of drillings taken for analysis. The analysis consists of solution of the drillings in 20 per cent. hydrochloric acid solution followed by filtration of the residue, washing with hot 1 : 1 hydrochloric acid, ignition and treatment with hydrofluoric acid to remove any silica present. The weighed residue is calculated from alumina to ferrous oxide from the oxygen equivalent of the two.

Oxygen Determined in Liquid State

The chief advantage of this method is that it determines the total oxygen in the liquid state and not in the solid state, and that it avoids the loss of oxygen during solidification of the test piece. The method should be of considerable value in determining the oxygen content of both open-hearth and bessemer steels before any deoxidiser is added to the furnace or ladle. If deoxidisers have been added the method may give erroneous results in that the aluminium will reduce manganous oxide and some silica. It is therefore best to use this method on steel before deoxidation and to use either the hydrogen reduction or the vacuum fusion for steels after deoxidation.

Molybdenite Mining in Quebec

ACCORDING to the *Northern Miner* (Toronto), the property of the Molybdenite Reduction Co., Ltd., operating in La Corne Township, south of Amos, Quebec, on the National Transcontinental branch of the Canadian National Railways, has been acquired by Hollinger Consolidated Gold Mines, Ltd., for development. The Molybdenite Reduction Co., Ltd., has, it is stated, opened up a considerable body of ore, and last year constructed a 100-ton mill from which concentrates were despatched in June, 1929. The Hollinger Co. is stated to be planning the opening-up of new levels and further development work in other directions, and an eight to ten-drill compressor is being ordered to take the place of the existing two-machine plant. This molybdenum deposit is one of the few which have yet been exploited in Canada, and it is the only one on which a mill has been erected. It may be recalled that the metal is used in the toughening of steel, and is in good demand in the United States and elsewhere.

Metallurgical Topics: Monthly Notes and Comments

From Our Own Correspondents

Zinc Industry in Italy

Our Italian contemporary, *La Metallurgia Italiana*, is very warmly to be congratulated on its new and very attractive issues. They are beautifully printed and illustrated, and, what is better still, contain a number of very excellent articles. The latest number has one by Signor G. Sirovich, on "Welding as a Method of the Manufacture of Metallurgical Plant," and the concluding article of a series of three, by Signor F. Sartori, on "The Metallurgy of Zinc in Italy." The latter supplies food for very serious thought, in view of the contrast between the developments in the zinc industry in Italy during the last dozen years or so and that of our own country. Almost the last of the zinc works in South Wales has recently been closed down, and although it is understood that efforts are being made to establish an electrolytic zinc industry in the Principality, the zinc situation is not one in respect of which it is possible to be very hopeful so far as this country is concerned. This is the more unfortunate inasmuch as the Government has, at a cost of well over a million pounds, been helping the industry with a subsidy in the way of purchasing its supplies of zinc concentrates for smelting. Belgium and Silesia both have thriving zinc industries despite handicaps from which Great Britain should ostensibly be free. We cannot make zinc "pay," yet, according to Sartori, Italy can and does. There are still, it would seem, a good many things "that they manage better" abroad.

A Record of Progress

Zinc has been produced in Bristol since 1743, whereas until 1869 there was no zinc industry in Italy. Its beginnings were meagre, and the first smelting furnace, which worked on zinc residues and not on ores, was put into operation at Turin in 1890. The production of zinc in Italy in 1928 amounted only to 10,000 tons, but the ore mined in that year, the bulk of which was exported, was equivalent to 70,000 tons of the metal. Much of this Italian works are now prepared to treat at home, both by the electrolytic method and by the Coley extraction process, which has commended itself to the zinc interests of the country as specially suitable to the native and Sardinian ore supplies. Thus, in 1929, the production of zinc rose to 18,000 tons, while in the present year it will probably attain 22,000 tons. To double the output in two years is a sign of health which the British industry—whose output continues, even with Government help and ample Australian ore supplies, to dwindle—can hardly help regarding with some degree of envy. It is true that the Sardinian ore is cheaply transported, but, owing to climatic conditions, mining operations can only be carried out during certain months in the year. Also, Italy enjoys ample cheap electrical power, hence the future of electrolytic zinc production in that country seems assured. Italian zinc consumption is well ahead of the current production, but if things progress in the near future as well as they have in the past, the country will, in a few years' time, be self-sufficing, an object the Fascist Government loses no opportunity of earnestly promoting.

Sizing Materials for Blast Furnace Charges

The grading of the materials charged into the blast furnace is a recognised mode of securing the uniformity of conditions and economy of fuel upon which efficient blast furnace practice so largely depends. Mechanical difficulties in dumping materials into different ore and coke bunkers, cost of handling and other considerations have, in current British practice, prevented the known advantages of grading to size being made the most of, but a good deal of trouble is taken in this respect at many works abroad and a considerable research work on the subject has been done in America. Much of this has been carried out under the auspices of the Bureau of Mines, Washington, and published by the Department of Commerce. In connection with the broad principles involved arises the question of what is the best size, and how to attain it. This, of course, will depend upon a number of factors: the nature of the ore, fuel and fluxes; the furnace lines and conditions of drive, and the kind of pig iron which it is desired to make. A very useful paper bearing on the subject has just been published by the Bureau on "A Method of Comparison of the Size of Materials Used in Blast Furnace Burdens." It is by Mr. S. P. Kinney, who has done a lot of previous work on blast furnace problems of a kindred nature.

The Method of Screen Analysis

The particular object in view was to enable the blast furnace operator to determine the size of the materials of the burden, and the method employed was by screen analysis, whereby the average fineness of the charge can be ascertained. From the data obtained a knowledge of the behaviour of furnaces working on different sizes could be determined, as well as the associated problem of the behaviour of the same furnace working on different sizes. Moreover, the results are comparable and form a useful guide. Tables are given of burdens charged at the works of the Columbia Steel Corporation, Utah, representative of three sizes, as well as practice with Mesabi ores. Methods of calculating and averaging the results of screen analysis are described in respect of coke, limestone, coarse, medium and fine ore, manganese ore, silica rock and slag, and thus obtaining the "average particle size" of the individual materials and of the burden as a whole. In each case the weight and volume bases of the materials have been calculated to correspond and thus provide ample data from which to guide practice.

Another Large Metal Company for Canada

An announcement has been made at Toronto of the formation of the National Lead Co., Ltd., which is to acquire the Canadian interests of the National Lead Co. of New York, one of the world's largest manufacturers of lead, tin and other metals. The new Canadian company to be controlled by the New York house has been capitalised at $5,000,000, partly subscribed by the parent organisation in the United States, and partly subscribed by the Canadian firms in the amalgamation. The National Lead Co. of Canada, Ltd., will control a variety of industries extending from Montreal to Vancouver and including the properties of the Hoyt Metal Co. of Toronto, the Canada Metal Co. (with factories in Toronto, Winnipeg, Vancouver and Montreal), and three smaller companies with plants at Montreal, Winnipeg and Vancouver respectively. Among the products to be manufactured are included lead pipe, solder, Babbitt metal, brass castings, sheet lead, etc.

Ontario Nickel-Copper Industry in 1929

The enlarged scale on which the nickel-copper mining industry of Ontario is being carried on is dealt with at some length in the Report of the Ontario Department of Mines on the metal production of the province during the first nine months of 1929. The two smelters of the International Nickel Co. of Canada, one at Coniston (Mond) and that at Copper Cliff (International), continued to enlarge their operations, ore being drawn from the Creighton, Garson, Levack and Frood Mines. As compared with the first nine months of last year, ore mined increased by almost 41 per cent., ore smelted by more than 42 per cent., while matte output was up by more than 48 per cent.

An interesting statement is that shipments during the period from the Mond section of the new Frood mine totalled 95,484 tons, and were consigned to both Copper Cliff and Coniston smelters. The total quantity of ore raised from all the mines was 1,466,356 tons, compared with 1,042,263 tons in the corresponding period of 1928, and 996,286 tons in the same period of 1927. The ore smelted during the first nine months of 1929 slightly exceeded the ore raised, being reported as 1,495,829 tons. The matte produced increased to 95,411 tons from 64,580 tons in the first nine months of 1928, while the nickel content increased to 86,244,108 pounds from 61,835,389 pounds, and the copper content to 64,699,643 pounds from 41,463,757 pounds.

Matte exported decreased from 28,745 tons to 17,553 tons, which indicates that the major portion of the refining is now being done in Ontario. The figures on matte treated in Ontario show an increase for the respective nine month periods from 29,513 tons in 1927 to 47,900 tons in 1928 and 78,990 tons in 1929, an increase for the current period in matte treated in the refinery of the International Nickel Co. at Port Colborne of almost 65 per cent. Increases in the quantity of products made were: metallic nickel, 54·5 per cent converter copper, 70 per cent., and nickel oxide, 15·5 per cent.

Trade, Commerce, Finance: The Month in Review

From Our Market Correspondent

THE outlook in the iron and steel trade is no more promising now than it was last month, but as no improvement was expected there is relatively little disappointment. The adverse influences which are so detrimental to trade have not been removed, the cloud of uncertainty which has been hanging over industry for the past few months has not lifted, and so long as these unfavourable conditions prevail it is useless to expect any betterment in trade. The old complaint is still heard in all sections of the steel market: orders are very difficult to obtain, and those that are secured are, in too many cases, subjected to such fierce competition that the price makes them hardly worth having. The troubles which beset the iron and steel trade are largely political and outside the control of the industry itself. They have been pointed out on numerous occasions, and both in the Press and at public functions the cry goes up for Government assistance in easing the burdens which Government action has imposed. It is not a hopeful appeal. The insistence on the necessity for safeguarding iron and steel grows ever stronger, but if it could not be obtained under the late Government, which believed in protective action of this kind, what hope is there of getting it from the present Government which is known to be averse to safeguarding? It may be that the increasing number of unemployed and the financial plight of the trade may compel national action, but this will not have to be delayed much longer.

Ruthless Price Cutting

These external evils are bad enough, but they are intensified by the selfishness which is still one of the worst characteristics of the steel makers as a whole. In a time of shortage of work there are too many steel makers ready to throw aside all economic considerations and ruthlessly cut prices so as to divert orders from other works. One would think that the disastrous results of this policy of orders at any price would have killed it, but it is not so. "It is the work we want, never mind the price" was the statement recently made by one of the large steel works, and so long as such a spirit actuates business there is not likely to be any return to prosperity. It is a great pity that in bad times such as we have experienced for such a long period, there is not whole-hearted co-operation amongst all steel makers so that the evil effects of external influences can be confined within the narrowest limits. Such a time is most opportune for a tightening of the control exercised by the Steel Associations, or a widening of its scope so as to include all classes of finished steel. Then, although a reduction in the volume of business could not be prevented when the cause lies in political movements, there would at least be an avoidance of unrestrained price cutting which does so much harm to the trade. It is bad enough to be short of orders, but it is worse to be faced with a serious fall in the selling price for what orders are available, when there is no necessity for it. A typical example can be found in the small bar trade. Orders for these bars have fallen off very considerably during the past few months, one cause being the waiting policy adopted by the motor car manufacturers in view of the uncertainty of the continuation of the safeguarding duty. As soon as this shortage became pronounced, certain steel makers reduced their prices in the hope of increasing their order book, at the expense of other works. Naturally these other works were anxious to retain their customers, and had perforce to meet the reduction in price. The net result therefore is the establishment of a lower price level for these bars, without any increase in specifications for rolling, which is what the mills need. It is all very obvious, but the lesson does not seem to get home, or there would not be these continual repetitions of the experience.

Need for Wider Control

This question of the complete control of steel prices, instead of the partial control which is now exercised, is likely to be brought up again in the near future. The control of selling conditions and prices for steel sections and plates has proved wholly beneficial to the industry, without inflicting any hardship on consumers. It has maintained prices at a level which, although unremunerative in some instances, has been higher than could possibly have been reached under free competition; it has enabled the steel makers to resist the pressure from consumers who sought to take advantage of the depressed condition of the industry; and it has brought the steel makers into closer touch with each other and so provided opportunities for joint action in the interests of the industry, such as the export selling scheme which is now being worked. The weakness of the position lies in the fact that so large a proportion of the output of steel lies outside the control of the associations. Billets, small bars, and boiler plates are still free. It is true that there are district associations in all three classes of steel, but as they include only part of the producers, their influence is not worth much. The boiler plate association which used to control the price of acid steel boiler plates is practically defunct, as there are so many makers who refuse to be bound. The trouble with small bars is that so large a production comes from the re-rollers, but even they are coming to the conclusion that it will be better for them, as well as for the steel makers, to have prices controlled, at any rate for the home market. Steel billets might well be left as they are, but small bars and boiler plates ought certainly to be brought under the control of the steel associations, every producer in the kingdom being a member of one or other of the sectional associations which, in joint meeting, exercise the actual control. It is not the slightest use trying to work a scheme which allows some makers to be free to quote as they like. All must be in to make it of any real value. There may be developments on this line to report in the near future.

Safeguarding Secrecy

The disastrous effect of the secrecy as to the Government's intentions towards the safeguarding duties is more and more noticeable as the weeks go by. Production is being curtailed, unemployment is increasing, and development plans are being postponed or definitely abandoned. The steel works are affected principally in the motor trade requirements. The dullness in this branch of industry is in striking contrast to the activity which prevailed in the early part of last year. Reports have appeared in the Press, which indicate that Mr. Snowden may yield to the pressure put upon him by his colleagues and allow some of the duties to remain, but no official statement is made, and until we get that, or until the Budget appears, there is not likely to be any improvement in trade.

Fall in Coke Prices

About the only satisfaction which the iron and steel makers can derive from the experience of the past two months is the fall in the prices of blast furnace coke and steel scrap. There is a reduction in the demand for both commodities, while the production of coke is increasing owing to the starting up of new ovens. Coke prices have fallen at least 2s. per ton, and still lower prices could no doubt be obtained by pressure. Scrap is rather a drug on the market, and the price has fallen about 10s. per ton since towards the end of last year. However, the advantage is probably only temporary, as both materials will harden as soon as the steel works become busier.

The pig iron markets are very cheerless just now. Prices are being maintained, but buying is very restricted, and makers have either to increase stocks or reduce output. That is the general position in all districts. There is no change to report in the finished steel markets. Everywhere there is a feeling of depression, business is intermittent and in most cases the mills are dependent on each day's inflow of orders, which only too often is very meagre. Official prices of sections and plates are unchanged. There is a tendency for billet prices to fall slightly, whilst the prices of small bars and boiler plates depend on the limits to which makers will go in their anxiety to get orders.

The output of pig iron during January was 650,000 tons, compared with 643,000 tons in December, there being three furnaces less in blast at the end of the month than at the beginning. The output of steel amounted to 771,100 tons, compared with 661,200 tons in December and 815,000 tons in November.

Some Inventions of the Month

By Our Patents Correspondent

Abstracts of other Patents of metallurgical interest will be found in our Patent Literature, published weekly in THE CHEMICAL AGE.

Alloys

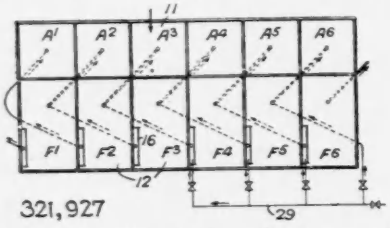
AN alloy particularly suitable for structural use, described in Specification 322,446, dated September 3, 1928, by C. P., O. F. A. and N. P. P. Sandberg (trading as the firm of Sandberg) and J. W. Bampfylde, of London, consists of 11-16 per cent. of aluminium and 84-89 per cent. of iron. It may be prepared by melting commercially pure iron with aluminium and pouring at about 1,600° C. Up to about 0·5 per cent. of silicon may be added.

MAGNETIC alloys described in Specification 323,222 (Beatty), dated September 24, 1928, a communication from Bell Telephone Laboratories, Inc., of New York, consist of 20-54·5 per cent. of nickel, 20-40 per cent. of iron, 15-20 per cent. of cobalt, and up to 10 per cent. of one or more of the elements molybdenum, tungsten, manganese, vanadium, tantalum, zirconium, copper, silicon or chromium. To develop high permeability at low magnetising forces, the alloys are subjected to one of the following heat treatments: (1) Heating to 800-1,150° C. until the temperature is uniform throughout, and subsequently maintaining for a time at 400-500° C.; (2) heating to 1,000-1,150° C., cooling to 400 °C. at ½-5° C. per minute, re-heating to about 600° C., and cooling at 5-25° C. per second; (3) heating to about 1,100° C. for one hour, cooling at not more than 200° C. per hour to 600° C., and cooling to 400° C. in more than two hours. Methods of annealing the alloys when uniformly loaded on conductors are also described.

AN aluminium alloy, containing 0·5-5 per cent. of copper, 0·1-1·7 per cent. of magnesium, 0·2-1·5 per cent. of nickel, 0·6-1·5 per cent. of iron, over 0·5-2·8 per cent. of silicon, and up to 0·3 per cent. each of manganese and titanium, is made by the addition to aluminium of alloys rich in one or more of the other elements. See Specification 323,353, dated December 18, 1928, by H. C. Hall and T. F. Bradbury, of Derby.

Concentrating Ores

AN arrangement of froth-flotation devices for concentrating ores is described in Specification 321,927, dated August 18, 1928, by P. T. Williams and Minerals Separation, Ltd., of London. A series of cells each comprising an agitation compartment 11 and a froth-forming compartment 12 is provided, and one or more of the end cells, and preferably also the other cells, are fitted with an auxiliary outlet in the form of a weir 16 disposed at a point, such as somewhat below

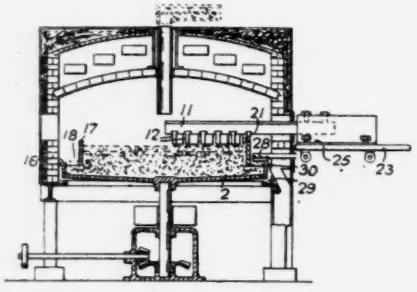


321,927

the froth level, where the pulp is normally more dilute than elsewhere. These outlets serve for passing pulp to the next higher cell of the series. In the preferred arrangement shown the outlet 16 communicates with the pipe conducting the outflow from the first froth-forming compartment F^1 to the next agitation compartment A^2, which thus becomes a slime-treatment cell, and water is supplied from a pipe 29 to the weirs of the froth-forming compartments F^4, F^5, F^6 and to the agitation compartment A^6. The coarse portion of the tailings follows the path A^3, F^3, A^4, F^4, A^5, A^5, A^6, F^6, and the bulk of the slime follows the path F^3, A^2, F^2, A^1, F^1.

Furnaces

A REDUCING furnace adapted more particularly for extracting tin is described in Specification 323,159, bearing the International Convention date January 29, 1929, by Cayzer Tin Smelting Co. (Proprietary), Ltd., of Johannesburg, South Africa. It is of the kind comprising a rotary hearth 2 supporting a mass of material such as spongy iron, through which the molten metal percolates, and a rabble 11 is so arranged in relation to a rim 17 on the hearth that molten metal can collect in a pool on the surface of the charge. A scraper-blade 21 lifts the solid residue over the rim 17, whence it falls



323,159

into an annular space 18 where it remains long enough to allow any molten metal to drain off. The residue is finally discharged by a scraper 28. The rabble 11 is of carborundum with carbon teeth 12, and is uncooled. The rim 17 may in some cases be formed by the material under treatment.

Iron

THE production of a heat-resisting and machinable grey cast iron is described in Specification 323,076, dated October 26, 1928, by British Cast Iron Research Association, A. L. Norbury and E. Morgan, all of Birmingham. It contains 4-10 per cent. of silicon, with or without up to 10 per cent. of aluminium, and fine division of the graphite flakes is ensured by suitable control of the melting temperature and rate of cooling of the casting. Phosphorus, sulphur and manganese may be present in the customary proportions.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

Mortgages and Charges

[*NOTE.—The Companies Consolidation Act of* 1908 *provides tha every Mortgage or Charge, as described therein, shall be registered within* 21 *days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.*]

DAVY BROTHERS, LTD., Sheffield, ironfounders. Registered January 25, £50,000 debentures, balance of £150,000; charged on properties in Sheffield, also general charge. Registered January 30, £200,000 debentures, inclusive of £150,000 already registered (secured by supplemental trust deed dated January 14, 1930); charged on Park Iron Works and Darnell Works, Sheffield, etc., also general charge. *£106,400. July 15, 1929.

FLETCHER, HOUSTON AND CO., LTD., Tipton, iron merchants. Registered January 16, £200 debentures, part of £2,000; general charge. *£500. December 31, 1928.

Satisfactions

ASSOCIATED LEAD MANUFACTURERS, LTD., London, E.C.—Satisfaction registered January 22, £184,226, registered May 1, 1925.

CARGO FLEET IRON CO., LTD.—Satisfaction registered January 22, £12,500, part of amount registered January 23, 1905.

BRITISH AND SAAR STEEL CO., LTD., London, S.W.—Satisfaction registered February 4, £1,800, registered April 4, 1927.

COPE AND TIMMINS (LONDON), 1911, LTD., brass founders, etc.,—Satisfaction registered February 8, £10,000, registered May 7, 1926.

Monthly Metallurgical Section

Published in the first issue of "The Chemical Age" each month.

NOTICE.—Communications relating to editorial matter for our Monthly Metallurgical Section should be addressed to the Editor, THE CHEMICAL AGE, *Bouverie House, 154, Fleet Street, London, E.C.4. Communications relating to advertisements and other business should be addressed to the Manager. Contributions will be welcomed from correspondents on any points of interest to metallurgists bearing on works practice or current research problems.*

The Formation of Alkaline Cyanides in the Blast Furnace

By W. McConnachie

The author deals with a subject that has exercised the minds of investigators since 1845, when the theory of Bunsen and Playfair was announced, and offers suggestions that indicate the possibility of a considerable advance on existing knowledge.

So far as the writer is aware, no one has succeeded in finding any more rational explanation of the formation and presence of cyanides in the furnace than that of the original discoverers—Baron Bunsen and Dr. Lyon Playfair—in 1845.

Notwithstanding the extensive and painstaking research of Sir T. Lowthian Bell, and others in more recent times, the whole subject is shrouded in mystery, and is as little understood as is the real reason for the marvellous change and progress in iron production due to the use of the hot blast—the last (and commonly accepted) explanation of which is, to anyone who has made himself familiar with the conditions of blast furnace work at the date of its introduction, just as unsatisfactory as was the first explanation given by Dr. Clark in 1835.

The Bunsen and Playfair Theory

All authors who have discussed this subject of the cyanides in the furnace seem to have accepted without question the dictum of the discoverers as to where and how they are produced, while opinion as to their importance or otherwise is unsettled, no one seeming to know whether they should be regarded as other than an unavoidable nuisance. It is disconcerting, therefore, to find, after 85 years, that the original data published by the discoverers contains all that is needed for a rational hypothesis as to their formation and behaviour to be formulated. They obtained their data from a Derbyshire furnace which used raw coal as fuel. At a point in the furnace, midway between two tuyères and 33 inches above the level of the tuyères, they took off a measured quantity of gas and estimated the amount of potassium contained in it, amounting (according to Bell) to 2·6 grammes per cub. metre.

As their sampling tube did not project into the furnace, the sample only represents the gases next the wall of the furnace. On analysing the gas, they found the nitrogen less in amount than was expected, and concluded that it had been absorbed in the formation of the potassium cyanides they discovered to be present. With 99·2 parts of nitrogen present they found 22·8 parts of oxygen instead of 20·8 parts, which, on correcting for that of the water in the blast, they thought would be present. Put in another way, instead of the expected 380·7 parts of nitrogen per 100 of oxygen, they found only 347·3 parts of nitrogen, equal to a disappearance of 8·77 per cent. of the latter gas.

As the quantity of cyanide found was only 2·6 grammes per cub. metre, it is quite evident that some other reason existed for the scarcity of nitrogen, there being a very large quantity of nitrogen injected with the blast, and, while much larger quantities of cyanides have been found in the furnace by various observers, no one has recorded ever finding any such quantity as would call for 8·7 per cent. of the nitrogen of the blast for its formation—(equal to 80 grams of K C N of mixed cyanides per cub. metre have been found).

Low Ratio of Nitrogen to Oxygen

The true explanation of the low ratio of nitrogen to oxygen in the gases at this point lies in the fact that the accompanying carbon gases are not all derived from the direct action of the blast on the fuel, but are formed in the "well" of the furnace, principally by the deoxidation of metal which has been oxidised by the blast after fusion, or of such oxides of the ore as have escaped reduction on their way through the furnace. This very obvious source of oxygen is very often overlooked, as it was in their case.

The gases so formed are not associated with nitrogen, but on rising in the furnace, as they must, are obstructed by the ingoing horizontal streams of air, and are deflected towards the outer quieter part of the sectors, next the wall, and so rise in the furnace, mixed of course, with some of the productions of direct combustion by the blast, so that it is not difficult to understand the relative absence of nitrogen in the gases next the wall at low levels in the furnace, which scarcity we find Sir T. Lowthian Bell, with Dr. Percy and others in earlier days, finding impossible of explanation.

It is difficult to see how the discoverers could claim that cyanides can only be formed in the hottest part of the furnace, even when bearing in mind that the production of an alkaline cyanide is an endothermic operation, for they themselves demonstrated that quite a moderate temperature is sufficient.

Results of an Experiment

Desiring to make certain if atmospheric nitrogen could combine with carbon and potassium to form cyanide, they arranged an experiment by which they attained their object, and each detail of this experimental test is of the utmost importance in solving the problem.

A mixture of 2 parts of charcoal from sugar, therefore, containing no nitrogen and 1 part of chemically pure potassium carbonate, was put into a gunbarrel, set in a furnace and heated. Atmospheric nitrogen was passed slowly through, and it was found that cyanide was copiously formed when the temperature was high enough to reduce potassium. As the operation was conducted in a gunbarrel, we see that a temperature below the melting point of iron is sufficient, and it would seem safe to infer that potassium was not produced until potassium oxide was vaporised.

We may then deduce from their successful experiment that cyanides of the alkalies may be produced from the combination of some nitrogen of the blast with carbon and an alkali metal at any place in the furnace where there is alkaline oxides as vapour, a large amount of carbon surface, where the gaseous atmosphere contains nothing more oxidising than carbon monoxide, and where the temperature approaches a white heat. The whole subject being bound up with the behaviour of the alkalis in the furnace, it is necessary to have a clear idea of what happens as they circulate.

Further Explanation Wanted

Bunsen and Playfair, followed by Sir T. Lowthian Bell and others, have assumed that the alkalis, which had been vaporised above the tuyères, were condensed to the liquid or solid state by the cooler materials, and were carried down on the surface of the descending materials and so again became available for the formation of cyanides in the hottest part of the furnace. But, of course, any such alkaline fume on the surface of the materials would be vaporised again before it reached the hottest part of the furnace, and so some other explanation is required as to the descent and accumulation of the alkalis which invariably occurs. The explanation is simple enough. The alkaline silicates which reach the well of the furnace in the primary slags are there decomposed by lime and the alkalis are vaporised as oxides. Those freshly liberated and consequently active oxides are moved towards the outer sectors of the hearth and carried upwards with the other gases generated in the furnace below tuyères level, but on their way come in contact with carbon surfaces in great quantity, so they

become reduced to their respective metals, which, with nitrogen and carbon, form the cyanides. The cyanides, rising with the gases from the well, which latter are specially rich in CO, may be decomposed by unreduced oxide of iron, the probable reaction (according to Bell) being $2\ KCN + 3\ FeO = K_2O + 2CO + 3\ Fe + 2N$.

As we have seen that cyanides may be formed where there is the vapour of an alkali as oxide, plenty of carbon surfaces, and a reducing atmosphere, we can easily understand that the cyanides may be formed, broken up and re-formed repeatedly on their upward path, so long as the temperature is high enough.

The various alkaline compounds rising in the furnace with the gases come in contact with heated materials, and of course combine with anything capable of fixing them such as MnO, Al_2O_3, but principally SiO_2, forming, with the substances they dissolve, primary slags which again reach the well of the furnace, and are again decomposed by lime. There is thus a continuous circulation of the alkalis (which leads to accumulation) in the furnace, and a continuous production of the cyanides. It will be evident that a much greater amount of alkali will pass out in the exit gases when the ores used are of the self-fluxing variety, and that the greatest interception will take place with ores containing free silica.

Rate of Cyanide Formation

As to the rate at which cyanides are formed, it is difficult to arrive at any very definite figures, as the points at which the cyanides carrying gases were obtained are rarely sufficiently definitely stated by the observers. As the reducing conditions are at their greatest in the sectors of the furnace next the wall and between tuyères just on the surface of the liquids, it is there that the cyanides will be formed most freely. Gases taken slightly above tuyère level, but midway between the line of two tuyères, have been found to contain up to 5 lb. of cyanides per 1,000 ft. of gas, the samples tested being from about 150 cub. feet of gas over 2–3 hours.

As the gases between two tuyères contain the normal ratio of O_2 to N_2, and as gases at the same level but near the wall contain much less nitrogen, we can in this way get an approximate estimate of the quantity being produced in any special case. Van Vloten found gas near the wall to contain 45·25 per cent. CO with 52·75 per cent. nitrogen, and midway between two tuyères, but nearer the centre, there was 33·75 per cent. CO and 64·5 per cent. N_2. Ignoring the N_2 used up in forming the cyanide, the amount of gas carrying the cyanides will be in proportion to the total amount of gas due to the blast as the nitrogen is to the total nitrogen of the blast used.

So that, if even only 12 cwt. of carbon are oxidised to CO by the blast directly or indirectly, some 40,000 cub. feet of CO are formed and with this there is 76,150 ft. or so of nitrogen, altogether say 116,000 cub. feet per ton of iron made, and, as the cyanide carrying gases contain only 52·75 per cent. N_2 as against 64·5 per cent. N in the normal gases from the blast, there will be about 95,000 cub. feet, giving about 475 lb. of cyanide per ton of iron produced.

Correcting this for the N_2 absorbed in the formation of the cyanides reduces the amount somewhat. Large as this amount appears to be, it is considerably under what Bell reports having found on one occasion at a low point in the furnace, but as we cannot trace how much gas per ton of iron he credited the furnace with at the point where the cyanides were found, we cannot definitely say whether they are in agreement or not. In any case the quantity continuously being formed is large enough to be of importance; indeed, it may well be that Bunsen and Playfair were perfectly right in their contention that the formation, destruction, and reformation of the cyanides plays an all important part in blast furnace work, although wrong as to where and how the cyanides are formed continuously.

Rhenium Metal and its Compounds

Some Recent German Research

The element Rhenium, which has the atomic number 75, was discovered about five years ago, and although its discovery was doubted in certain quarters for a time, it is now definitely established and the element is found to have its place in the Periodic System under manganese.

THE discovery of Rhenium is claimed by Ida and Walter Noddack, who have since extensively investigated its occurrence in Nature and its properties. These investigators give interesting information on the results of their work in this direction in the chemical-metallurgical journal, *Die Metallbörse*, of March 19. The following is an abstract of this information:

In 1925 the authors examined 30 complex minerals, in five of which they believed to have identified Rhenium. Since then they have examined about 1,600 minerals from all parts of the world and found Rhenium in about 100 of them. With financial support from German scientific bodies, the authors were able to visit Scandinavia and Russia, to search for and acquire rhenium-containing minerals, but in no case did they find any containing more than 0·001 per cent. of the element. While at the end of 1926 they had isolated about 2 mg. of the element, by the end of 1927 they had obtained about 120 mg. In 1928, with the assistance of the Siemens and Halske interests, they obtained about 1 gram of the material from 700 kg. of molybdenum glance. By the middle of last year this quantity had been increased to 3 grams, but later in the year they were able to obtain a mineral by-product of a certain industry comparatively rich in Rhenium which permitted the production of the element on a comparatively large scale. At present there is available several hundred grams of rhenium, partly in metal form and partly as compounds.

In 1929 the German Atomic Weight Commission accepted the atomic weight of rhenium as 188·7. The metal can be obtained by the reduction of its sulphide or dioxide with hydrogen at a suitable temperature. The reduced material is in the form of a loose black powder containing some hydrogen, but by compressing this under heat a metal is obtained in stick or plate form of high strength. When melted in the electric arc furnace, a silver-white and bright surface product is obtained; platinum filaments heated to glowing in an atmosphere of rhenium chloride become plated with metallic rhenium. The metal is of great hardness and takes a high polish: its melting point lies between those of osmium and tungsten. The authors have been able to determine the specific heat, the atomic heat, and many of the physical properties, including electrical conductivity, but they supply no figures for these. The element has some characteristic lines in the spectrum, regarding which F. Paschen and his coworkers, as well as others, have made investigations. Since larger supplies of the element have become available, it has been possible to supply other investigators with small quantities, some of whom have already obtained and published new information regarding the element.

Properties of the Metal

Analytically, rhenium belongs to the hydrogen sulphide group in that in its solutions, acidified by hydrochloric or sulphuric acid, it yields a black sulphide with H_2S, which is only very slightly soluble in alkaline sulphide solutions. A residual material containing rhenium, fused with caustic alkali, forms a yellow coloured melt from which the alkali rhenates can be extracted with water to form a colourless solution from which they cannot be precipitated either by acids or ammonium. This permits an easy separation of the rhenium from associated metals, except arsenic and molybdenum. When rhenium is present to the extent of 0·5 per cent. in a mixture containing other heavy metals, a reduction by hydrogen, followed by oxidation at a suitable temperature, results in the formation of two volatile oxides of rhenium. Also, when the metal burns in oxygen, a colourless gas is formed which condenses at about 350° C. to a yellow liquid, which becomes solid at about 220° C. and forms yellow crystals, chiefly in the form of hexagonal plates. This is the heptoxide Re_2O_7 which dissolves freely in water and alcohol. The water solution has an acid reaction; it dissolves zinc and iron with

the evolution of hydrogen. This acid is considered to have the formula $HReO_4$ and to be analogous to $HMnO_4$. The following salts of this acid have been obtained: $NaReO_4$, NH_4ReO_4, $KReO_4$, $CsReO_4$, $AgReO_4$, $Ca(ReO_4)_2$, $Ba(ReO_4)_2$, and $Nd(ReO_4)_3$. All these salts are colourless, so far as the base is without colour. The solubility of these salts and their behaviour towards different reagents have been investigated. Like permanganates, they are more or less freely soluble in water, except the silver salt which is only slightly soluble. The alkali salts can be melted in air without decomposition; the slightly acid or water solutions are not affected by weak reducing agents, but with stronger reducing agents they acquire a yellow colour. A concentrated solution of per-rhenium acid, when treated with metallic zinc, yields a black precipitate.

When rhenium metal or its compounds are melted with caustic alkali the melt is of an intense yellow colour; rhenates are formed which in the cases of the potassium and barium salts are pure yellow and probably also for others not yet investigated. The rhenates are much less stable than the corresponding manganates.

The Oxides

From the yellow rhenates it is possible to obtain a reddish yellow oxide considered to have the formula ReO_3, but so far it has not been obtained quite pure. Reduction of per-rhenium-acid, per-rhenates and the rhenates by hydrogen results in a lower oxide, which has the formula ReO_2. By careful reduction with sulphur dioxide, for example, a blue-coloured lower oxide is obtained whose composition lies between ReO_3 and ReO_2. By strong heating in the presence of hydrogen all the oxides are reducible to rhenium metal. There are still other oxygen compounds of rhenium; by the gentle heating of finely powdered rhenium in oxygen a white vapour forms which condenses at lower temperature to a snow-like mass whose formula is ReO_4 or more probably, Re_2O_8. When more strongly heated, this oxide loses oxygen and passes into the heptoxide, Re_2O_7. By a mild reduction, this oxide is converted into a violet-coloured oxide corresponding to about the formula Re_3O_4. So far, therefore, the following oxides of rhenium are known: Re_2O_8, coloured white; Re_2O_7, coloured yellow; ReO_3, coloured yellowish-red; lower blue and violet oxides whose exact composition is not definitely ascertained, and ReO_2, which is a black substance.

While the higher oxides of rhenium form acids, the others must function as weak bases, although the nature of their salts is not yet investigated.

Of the sulphur compounds of rhenium, the best known is the black di-sulphide ReS_2 which is obtained by heating the higher sulphides up to about 600° C. in a nitrogen atmosphere.

Rhenium must form numerous halogen compounds; so far the solid but easily volatile green heptachloride $ReCl_7$, the brown hexachloride, $ReCl_6$, and a brown bromide of unknown composition have been isolated. Bright coloured oxychlorides are also formed, but nothing has yet been done in isolating them.

Of the remaining rhenium compounds little is known qualitatively and practically nothing quantitatively. The larger quantities of rhenium now available for investigators generally, leads to the expectation that new information regarding rhenium and its compounds will soon be made known.

Metallurgical Topics: Monthly Notes and Comments

From Our Own Correspondents

The Late Professor J. O. Arnold

"THE University of Sheffield has learnt with regret the news of the death of Professor Arnold. There is none to whom it has been more deeply indebted, or whose memory it cherishes with more admiration and gratitude." So ran the message sent by Sir Henry Hadow, Vice-Chancellor of Sheffield University, in connection with the funeral at Windermere on Monday of Professor John Oliver Arnold, F.R.S., Emeritus Professor of Metallurgy at the University and a world famous metallurgist. Born in 1858, Dr. Arnold was intended for a seafaring career, but early entered the engineering department at the Sheffield Steel and Iron Works. He held several appointments in the laboratory and testing departments at local works, and was awarded a Telford medal by the Institution of Civil Engineers in 1887. In 1889 he was appointed Professor of Metallurgy at the Sheffield Technical School, and remained a member of the staff when the school was absorbed in the University. He effected revolutionary changes in his department by giving increased attention to the science of metals, in which his investigations were of great practical value. He remained at the head of the Metallurgical Department of the University of Sheffield from its opening till he resigned his professorship in 1920.

High Speed Steels

DR. ARNOLD accompanied the British Association to South Africa as a special lecturer on steel in 1905, was elected Fellow of the Royal Society in 1912, served on the council of the Iron and Steel Institute, and was made honorary vice-president in 1925. He was frequently consulted by the Admiralty, and gave valuable advice on the material used in naval construction.

During the war the best high-speed steel contained proportions of carbon, tungsten, and chromium. Dr. Arnold discovered that by substituting six per cent. of molybdenum for 18 per cent. of tungsten he could produce an even better steel, with only one-third of the amount of the most expensive element. His most important work was "Steel Works Analysis," which has long been recognised as a standard authority, and he was also the author of numerous papers on his researches, such as the molecular constitutions of high-speed steels, the influence of carbon on iron and of aluminium in traces on steel ingots, the influences of chromium, manganese, nickel, cobalt, vanadium, tungsten, and molybdenum on steel, the metallurgy of steel castings, and the discovery of about 25 micro-constituents of steel.

Iron and Steel Statistics

SEVERAL additions have been included in the latest edition of *Statistics of Iron and Steel Industries* in order to make still more complete the figures relating to the various countries Production figures for the United Kingdom are based on returns supplied to the National Federation of Iron and Steel Manufacturers by producers throughout the country, and the figures are now more complete than at any other period. Pig iron and steel ingot figures, for instance, are now received from all makers without exception, and a table has been included showing imports and exports of scrap iron and steel. The section dealing with tariffs on imports of iron and steel into certain countries has been enlarged by the addition of Chile and Portuguese East Africa, and the regulations governing the grant of British preferential tariffs in certain Dominions are given in detail. In the case of Canada a new table has been included giving the imports of iron and steel over a series of years, while a section has now been added for the Saar. The volume can be obtained from the offices of the Federation, Caxton House (East), Tothill Street, Westminster, S.W.1, for 5s. 5d., post free.

Blast Furnace Problems

THE many and invaluable contributions of the U.S. Bureau of Mines to the literature dealing with blast furnace practice serve to show how little is really known of a process concerning which every writer of elementary text books speaks so assuredly. It is not many years since all that was known was what was put into the furnace and what was produced therefrom. Thanks to the investigators at the Bureau, and elsewhere, we are beginning to learn something of the intermediate products and the *modus operandi* of the blast furnace and thereby to attain a greater measure of control. Among the latest experiments carried out by the Bureau are some relating to heat transfer problems and to the effects of methods of charging on size segregation and on gas flow. It is apparent that a knowledge of the laws governing the transfer of heat from a rising stream of hot furnace gases to a descending charge of

mixed, broken solids is one of the essentials in the development of a complete theory of the blast furnace. From the results of the Bureau's experiments it is concluded that the coefficient of heat transfer from a gas stream through a bed of broken solids varies as the 0·8 power of the gas velocity and is practically independent of temperature.

A general relation has been found in regard to the effect of voids on heat transfer, but a reliable mathematical relation is not yet determinable, the data not yet being sufficiently extensive. On the other hand, it seems possible to determine the relation between the coefficient of heat transfer and the resistance of beds to gas flow. In regard to the methods of charging blast furnaces, earlier work of the Bureau showed the relations between gas flow and size segregation. Experiments recently carried out, using small models, led to some general conclusions as to the effect of varying the method of charging on the distribution of the material charged. It is found that any change in the charging method that leads to more rapid discharge from the big bell tends to decrease the average particle size at the centre of the stock column, while factors tending to produce a more open centre are smaller charges of ore and coke, smaller bell clearance, alternating skips of ore and coke, and charging coke on the big bell first. It is concluded that measurements of the indexes of gas distribution, the gas temperatufe, gas velocity, and gas composition—give a direct method of attacking the distribution problems of individual furnaces.

Corrosion Research

A CONSIDERABLE amount of work on corrosion research is revealed in the annual report of the Council of the Institute of Metals. For discovering the effects of tube wall temperature on corrosion a small experimental condenser with short tubes heated by means of steam is in use. Many tests have been carried out with this apparatus, using sea-water containing entangled air bubbles and moving at about 9 ft. per second. A good deal of useful information has been collected, it is stated, although no greatly accelerated corrosion has taken place, except in cases of violent steam impingement.

A jet-test apparatus has been in use continuously throughout the year, chiefly in connection with work on the formation of highly protective films on the surface of condenser tube alloys. Particularly good results have been obtained with the special brass tubes containing aluminium, and it has been found that the natural film-forming properties of these tubes may be further improved by a simple preliminary treatment. The treated aluminium-brass has remained quite free from attack under conditions of impingement which are able to perforate a 70 : 30 brass tube in six weeks or less. The immunity to impingement attack has persisted even when the protective film has been deliberately injured.

Tests are in progress to determine to what extent some of the more recent condenser tube alloys resist the effects of adhering deposits of sand, etc. These tests are being carried out in hot sea-water. Up to the present, good results have been obtained with the 70 : 30 cupro-nickel tubes, and also with the aluminium-brass.

Aston Wrought Iron Process

THERE has been for some years past a noticeable revival, in the United States of interest in wrought iron, such as Staffordshire and Yorkshire people would only be too glad to see over here. Of the competing processes for the manufacture of this class of material—more are employed in America than have ever become commercially acclimatised in our own country—hand puddling has hitherto yielded the more satisfactory results. It is now closely challenged by the Aston process, which is a rather roundabout method of obtaining, by a sequence of operations, what the old hand-puddling process achieved in one. " Bessemer " grade pig iron is melted in a cupola ; the metal run out into a ladle and soda ash added to offset the sulphur " pick up " in the cupola ; skimmed free of slag, and poured into a side-blown Bessemer converter after blowing, and " shotted " into another ladle, containing slag " of the proper composition " from an open-hearth furnace presumably making steel. The " shotted " iron balls up into a coherent lump, in the shotting ladle, and is then withdrawn and heated, subsequently, in just the same way as the ball of puddled iron withdrawn by the puddles, in the usual hand-process of making wrought iron. It is well to know that, according to Research Paper No. 124 of the Bureau of Standards, Washington, the ultimate product is rather more satisfactory than might have been expected.

Distinctions for U.S. Metallurgists

MR. WILLIAM HASTINGS BASSETT, technical superintendent and metallurgist for the American Brass Company at Waterbury, Connecticut, was elected president of the American Institute of Mining and Metallurgical Engineers for 1930 at a recent meeting in New York. Five years ago he was chosen for the award of the James Douglas Medal for his " constructive research in copper and brass and other non-ferrous metals and alloys." Mr. Bassett, before associating himself with the brass industry, was formerly chemist to the Pope's Island Manufacturing Company, and was also a teacher of chemistry.

Dr. James Aston, director of metallurgy at the Carnegie Institute of Technology, has received the award of the Robert W. Hunt Medal from the A.I.M.E. The award was made for Dr. Aston's recent process for quantity production of wrought iron, which will be exploited at a new plant being built by the A. M. Byers Company at Ambridge, Pa. The process, it is hoped, will be of great importance in future apparatus and equipment construction.

The Iron and Steel Institute

THE annual meeting of the Iron and Steel Institute will be held this year on Thursday and Friday, May 1 and 2, at the Institute of Civil Engineers, Great George Street, Westminster, commencing each day at 10 a.m. There is a large number of papers for discussion and members are asked to make early application for copies of those in which they are particularly interested. On the first day the Bessemer Gold Medals will be presented to Mr. Eugene Schneider and Dr. W. Rosenhain, and the annual dinner is being held in the evening at the Connaught Rooms. Additional meetings are taking place at Birmingham Chamber of Commerce on May 6 and at the Royal Metal Exchange, Swansea, on May 13. Both are evening meetings and there will be discussion on several papers.

Ontario Copper and Nickel Production

THE amounts of copper and nickel produced from matte treated in Ontario in the first nine months of 1929 were : metallic nickel, 52,454,054 pounds, worth $12,864,312 ; converter copper, 50,007,324 pounds, worth $8,765,359 ; nickel oxide, 10,505,354 pounds, worth $2,417,474. Exports of nickel and copper in matte were : 16,386,989 pounds of nickel, worth $2,949,658, and 11,692,066 pounds of copper, worth $1,812,270. Including the small item of nickel content in salts and residues, the total value of nickel production in Ontario during the first nine months of 1929 was $18,287,762, compared with $15,852,603 in the corresponding period of 1928. The value of copper production was $10,579,858, compared with $5,922,685.

The report of the Ontario Department of Mines mentions preparations going on in the Sudbury field to provide for the large scale operations planned at the Frood mine. The new equipment in the form of bins, concentrator, roasters, reverberatory furnaces and copper refinery has been actively pushed, it is stated, and in construction a large number of skilled and unskilled labourers have been employed. Housing accommodation at Sudbury is taxed to the limit. With reference to the refining facilities at the Port Colborne refinery, the report points out that the new electrolytic units are practically completed, although the last two units are not yet in operation.

The Chemist and Scrap Metals

THE VALUE of chemical knowledge in the Scrap Metal Industry formed the subject of an address by Mr. Henry Hilditch, chief chemist with Chalmers and Co., Leith, at a meeting of the North British branch of the Pharmaceutical Society in Edinburgh. The greater proportion of scrap metals, he said, was alloys, and when they remembered that the inclusion of aluminium or manganese would completely spoil any scrap metal from the founder's point of view, then they would realise that the dealer's business was not only a highly skilled one, but was also highly responsible. The value of skilled technical and chemical knowledge in this connection was a comparatively recent development, and one which placed the industry on a more satisfactory basis.

Trade, Commerce, Finance: The Month in Review

From Our Market Correspondent

THERE has been no relief from the depression which settled on the iron and steel industry at the beginning of the year, and which has persisted right through the first quarter. This condition must be counted as abnormal, as it is a rare experience that the first three months of the year do not show some quickening in trade, even if it is only temporary. On this occasion, however, there have been no encouraging signs at all. It is no consolation to know that the majority of other industries have had the same unsatisfactory experience; in fact, that makes matters worse, as a general depression in trade only increases the difficulties of the steel works. It was hardly to be expected that there would be any recovery during the month of March. We have previously stated the reasons why trade has been so disappointing, and these were such as to preclude any hope of a sudden or early improvement.

Much Depends on the Budget

It may be that the month on which we have now entered may provide a happier story. Much depends on the revelations of the Budget. The optimist can see some relief ahead, no matter what the Chancellor decides to do or not to do. It is the uncertainty, the fears of what may happen, to which must be attributed the wait-and-see policy which has been so largely adopted by buyers, with the resultant falling off in business. When it is definitely known what the financial and fiscal policy of the new Budget is to be, this uncertainty will disappear, and traders will know what they have to face. If no disturbing changes are made, we may see a spurt in business which will help us to forget the melancholy quarter which has just ended. If some of the fears are realised, let us hope that it will inspire the determination to go ahead in spite of these adverse circumstances. There will be no longer an excuse for holding back business, and the flow of orders to the mills may resume a more happy and normal volume. Still, one must sound a note of caution. We are now approaching the middle portion of the year, when in the natural order of things business tends to recede. If, therefore, the revival is too long delayed, we may find this natural tendency asserting itself, cutting short the much-needed improvement in trade and prolonging the depression until the closing months of the year. The alternatives are there, and the wisest course is for each of us to set to with a will, in the determination to make the brighter of them become the reality.

It is not only the present shortage of orders that is disconcerting, but also the lack of inquiry for new business. Many of the steel makers find themselves in the unhappy position of having contracts booked against which specifications are not forthcoming, and very little demand outside contracts. It is not much use asking for specifications, as in most cases consumers themselves have not the orders to place, although instances are not wanting where contracts are deliberately held up while supplies are obtained from other sources on the more favourable terms which can usually be obtained, when there is a slump in trade, for material outside the control of the associations. It is, no doubt, an experience of this kind which has induced the Cleveland ironmasters to make so bold a reduction in the price of pig iron, to the extent of 5s. per ton. One is accustomed to changes of a shilling or so, or even up to 2s. 6d., but 5s. at one cut is rather unusual. The Cleveland makers had seen much of their business going from them to other suppliers, chiefly Continental and Indian, although the Midland makers had also encroached on this market. The 5s. reduction was made, in the middle of March, in the hope of regaining some, if not all, of this business. Reports indicate that some measure of success has been achieved, and that a distinct improvement has resulted from this reduction in price. It has certainly brought into the market those buyers who were waiting for the change, which had been expected for some little time.

No Change in Steel Prices

The associated steel makers, at their joint meeting in March, decided to make no change in the official prices. There was no question of an advance in view of the unsatisfactory trade conditions, and a reduction was hardly likely, as no advantage would have been gained thereby. With nearly 100 per cent. of the steel makers in membership, the joint Association can effectively exercise control, which is more necessary when trade is bad, as the temptation is strong for individual makers to seek to gain an advantage over others. As things are, there is no argument for a reduction, as all makers would have had to give it, and no increase of business would have resulted to any of them. As far as the controlled materials are concerned, plates and sections, the steel makers will, for a time, have the benefit of the lower prices ruling for coke and scrap. The fall in coke prices has materially reduced the cost of pig iron for steel making; and scrap prices are still very weak, the supply being much in excess of the demand. This benefit, however, will last only while the present depression continues. As soon as the steel trade becomes active again, the demand for basic iron and for scrap will revive and prices move upwards. However, it is something to the good that production costs are moving in the right way, and that this benefit is not being passed on immediately to the consumers, as is usually the case.

Furthering the Use of Steel

It is too early yet to judge of the success of the organisation which was created some months ago by the steel makers and engineering trades, acting in conjunction for the purpose of extending the use of steel for all manner of purposes in this country. The British Steelwork Association, as it is called, is actively at work, and there is reason to think that it will prove of considerable benefit to the trade. It is interesting to note that a similar organisation in Germany has proved extremely successful. There is a steel propaganda office in Dusseldorf, whose object is precisely the same in Germany as that of the British Steelwork Association in this country, and owing to its efforts the consumption of steel for buildings has greatly increased. It is stated that the estimated consumption of steel for structural purposes in Germany in 1929 was 250,000 tons, compared with 60,000 tons in 1927. There are many purposes for which steel can be used in place of other materials which have hitherto held the field, and energetic propaganda can secure some of these markets for the steel makers. The British Steel Export Association, formed by the associated steel makers, is also quietly pursuing its way, although so far no outstanding results have been achieved. The amount of business which it can set out to capture is very limited, being chiefly confined to plates, for which the demand from abroad has diminished considerably in recent years.

The Pig Iron Market

Conditions in the pig iron market have been rather changeable during the past month. In the Midlands there has been very little business done. Consumers are confidently expecting lower prices, but as they know that the existing rates will hold good until the end of April, they are not in a hurry to place orders, particularly as they themselves are rather short of work. In the Cleveland district, however, there has been more business passing, owing to the fall in price. Several good contracts have been placed, and orders are coming in better than they have done for some time. The improvement is expected to apply to the home markets, to the business with Scotland, and probably to the export trade. There is nothing of particular interest to report about the market for steel. Business is very quiet, orders of any importance are few and far between, and there is little inclination to put on new contracts. Buying for current needs seems to be the settled policy of consumers, and this patchy trading will probably continue for a few weeks longer.

Although there were three furnaces more in blast at the end of February than at the beginning, the output of pig iron was only 597,000 tons, compared with 650,000 tons in January. The output of steel amounted to 776,400 tons, compared with 771,000 tons in January.

Some Inventions of the Month

By Our Patents Correspondent

Abstracts of other Patents of metallurgical interest will be found in our Patent Literature, published weekly in THE CHEMICAL AGE.

Alloys

ALLOYS comprising 20-75 per cent. of iron, 5-20 per cent. of chromium, 5-20 per cent. of copper, 10-15 per cent. of nickel, and up to 10 per cent. of silver, with or without up to 2 per cent. of manganese, are described in Specification 324,009, dated October 11, 1928, by H. J. Henbrey and C. J. M. Thornhill, of London. The carbon content may be 0·12-0·45 per cent., the alloys of higher carbon content requiring annealing.

RUST-RESISTING iron alloys described in Specification 323,845, dated October 30, 1928, by J. T. Hay, of Canton, Ohio, U.S.A., contain 0·4-0·5 per cent. of copper, 0·05-0·1 per cent. of molybdenum, and less than 0·05 per cent. of carbon. From 0·1 to 0·15 per cent. of manganese and or not more than 0·005 per cent. each of silicon and phosphorus and/or not more than 0·04 per cent. of sulphur may also be present. The combined percentage of carbon, manganese, silicon, phosphorus, and sulphur is preferably below 0·25. Reference has been directed by the Comptroller to Specification 290,487.

Coating Metals

IN the application of a number of metal coatings to a metal the first coating is cleaned and freed from occluded gas by subjecting it to an electric discharge in a vacuum as described in Specification 286,632, the second coating is then applied and similarly treated, and so on. The application to the production of a hard track for a cylinder of an internal-combustion engine by coating the track first with nickel and subsequently with chromium is described. See Specification 323,847 dated November 1, 1928, by J. Von Bosse, of Ehrenberg, near Leipzig, Germany.

Coating with Metals

SURFACES to be coated with base metals by thermal decomposition of the carbonyls of the metals under reduced pressure are heated in a closed vessel to the decomposition temperature, other parts of the articles with which the carbonyl vapour comes into contact being kept below this temperature, if necessary by special cooling means. The articles may be brushed, before applying the coating, with a solution of a hydroxide or salt of an alkali or alkaline earth metal or with a solution of the sulphate of the metal to be deposited. Metal films are produced by depositing the metal on a crystalline or other soluble substratum, which is thereupon removed. Iron is deposited from iron carbonyl at 140-170° C. under a pressure of 30-50 mm., and nickel from nickel carbonyl at 150° C. under a pressure of 150-220 mm. The process is particularly applicable to the coating of light metal diaphragms with iron for microphones. See Specification 324,363 (Johnson), dated October 12, 1928, a communication from I.G. Farbenindustrie Akt.-Ges., of Frankfort-on-Main, Germany.

Copper

THE separation by froth-flotation methods of finely-divided copper from minerals or aggregates containing it in the metallic state is facilitated by treatment of the copper before or during the flotation operation with a cyanogen compound—*e.g.*, an alkaline cyanide. The presence, also, of a collecting agent, comprising a substance containing the xanthic radicle and the presence of an alkaline modifying agent, such as sodium silicate, are found to be advantageous. A suitable starting material is obtainable by a heat treatment of the mineral to produce reduced copper therein in a segregated form as described in Specification 250,991 (See THE CHEMICAL AGE, Vol XV p.7 [Metallurgical Section]) or by heating it in a reducing gas to produce copper at a temperature lower than the melting-point of copper, the product in each case being ground, if necessary, before subjecting it to the froth-flotation treatment. See Specification 322,527, dated September 7, 1928, by S. Tucker, of London.

Electrolytic Deposition of Alloys

AN alloy is deposited electrolytically from a solution containing a mixture of the salts of the constituent metals, the proportions of the salts falling within a range such that variation within this range does not affect the proportions of the metals in the deposited alloy. Thus an alloy containing 21·3 per cent. of nickel and 78·7 per cent. of iron is deposited from an electrolyte containing a proportion of nickel to iron ranging from 2 : 5 to 5 : 16. The deposition of an alloy of high electromagnetic permeability containing 77·2 per cent. of nickel and 22·8 per cent. of iron and suitable for use as an anti-corrosive plating or for loading cables is also described. The electrolyte in this case is preferably a solution of iron and nickel chlorides containing some free hydrochloric acid, the cathode being of nickel and the anode in part of iron, in part of nickel, and in part of graphite or a like inert material with such relative areas that the concentration of nickel in the electrolyte remains constant while that of iron increases. An alloy containing 80 per cent. of tin and 20 per cent. of copper and another containing 85·72 per cent. of tin and 14·28 per cent. of copper are deposited from electrolytes comprising solutions of the sulphates with a small proportion of sulphuric acid. See Specification 323,765, dated July 4, 1928, by B. Leech and F. Hammond, of Macclesfield.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

Mortgages and Charges

[*NOTE.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case, the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.*]

BALDWINS, LTD., London, E.C., steel manufacturers.—Registered February 13, trust deed dated February 12, 1930 (supplemental to trust deed dated December 8, 1928, securing £1,000,000 first debenture stock); charged on properties n counties of Glamorgan and Carmarthen, etc. *£3,810,354. May 10, 1929.

BEARDMORE (WILLIAM) AND CO., LTD., London, S.W., steel manufacturers.—Registered March 4, £150,000 mortgage to Lloyds Bank, Ltd., Royal Bank of Scotland, and National Bank of Scotland, Ltd.; charged on moneys due to company under certain contracts, etc. *£1,696,804. November 14, 1929.

CARNFORTH HEMATITIE IRON CO. (1915), LTD.—Registered February 18, charge, created by the receiver, to bank; charged on properties at Carnforth, etc., also general charge (ranking in priority to trust deed dated December 1st, 1915). *£266,620 debentures. £1,000 mortgage. April 3, 1929.

MERU TIN, LTD., London, E.C.—Registered March 3, two charges (supplemental to £5,000 debenture dated October 11, 1929), to Western Smelting Co., Ltd., Stafford House, King William Street, E.C.; charged on properties at Meru, Ipoh, F.M.S. *£5,000. December 27, 1929.

SOUTHERN FOUNDRIES (1926), LTD., Croydon.—Registered March 6, £7,000 debentures; general charge. *£87,370. January 3, 1929.

Satisfactions

BWANA M'KUBWA COPPER MINING CO., LTD., London, E.C.—Satisfaction registered February 26, £950, part of amount registered April 13, 1928.

FRODINGHAM IRON AND STEEL CO., LTD.—Satisfactions registered March 10, £40,000, part of amount registered October 12, 1917, and £7,495, part of amount registered June 20, 1925.

NORTH HENDRE LEAD MINING CO., LTD., Chester.—Satisfaction registered March 4, £1,600, part of amount registered June 19, 1902.

YORKSHIRE IRON AND COAL CO., LTD., Leeds.—Satisfaction registered March 3, £13,000 registered January 20, 1928.

Monthly Metallurgical Section

Published in the first issue of "The Chemical Age" each month.

NOTICE.—Communications relating to editorial matter for our Monthly Metallurgical Section should be addressed to the Editor, THE CHEMICAL AGE, *Bouverie House, 154, Fleet Street, London, E.C.4. Communications relating to advertisements and other business should be addressed to the Manager. Contributions will be welcomed from correspondents on any points of interest to metallurgists bearing on works practice or current research problems.*

Caesium, Rubidium and Lithium

By R. M. Santmyers

Caesium, rubidium and lithium, sometimes described as the minor or rarer alkali metals, generally occur together in Nature, although lithium is far more abundant than either of the other two. The following information concerning them is taken from Information Circular 6215 of the United States Bureau of Mines.

THE chemical, and even the physical, properties of these three elements can best be considered in conjunction with the more familiar members of the alkali group, sodium and potassium. The five elements—lithium, sodium, potassium, rubidium, and caesium—show an interesting gradation in properties from member to member with the increase in atomic weights. All are silvery white and soft enough to be cut with a knife. They tarnish rapidly in air and decompose water at ordinary temperatures. The lowest temperature at which the action of the several metals on water can be detected is −98° C. for sodium, −105° C. for potassium, −108° C. for rubidium, and −116° C. for caesium. The chemical activity appears to increase steadily from lithium to caesium. All manifest a remarkable affinity for oxygen, and caesium and rubidium ignite spontaneously if placed in dry oxygen at room temperature. On the other hand, sodium and lithium have feebler affinities. All the metals, however, lose their lustre at once when exposed to air. Sodium, potassium and lithium are stored in an oxygen-free liquid, such as water-free ether, naphtha, or kerosene, but rubidium and caesium must be kept in a vacuum.

Different values have been reported for the specific gravities, presumably because it is difficult to prepare the absolutely pure metals. All, however, are exceptionally light and have large atomic volumes. Lithium, in fact, is only a little more than half as heavy as water and is the lightest element solid at ordinary temperatures. It is the only one of the five that fails to melt below the boiling point of water, and its melting point is only 180° C.

Physical Properties of Salts

The oxides and hydroxides of the alkali metals are markedly basic. The physical properties of the salts—solubility in water, molecular volume, optical properties, and variation in form of the crystals—show the same order of variation as the atomic weights of the elements. The salts of the metals—nitrates, chlorides, sulphides, sulphates, phosphates, carbonates, etc., are nearly all soluble in water. However, the salts of lithium, notably the carbonated phosphate and fluoride, are much less soluble than the corresponding salts of the other members; in this respect lithium seems to be a sort of connecting link between the members of the alkali group and the alkaline earth group, of which calcium is the first member. The alkali sulphates form characteristic isomorphous alums, but lithium alum appears to be so soluble that it has not yet been crystallised. Sodium resembles lithium in the solubility of its chloroplatinate, acid tartrate, and alum, and this resemblance is so strong that the five alkali metals are sometimes divded into two classes according to whether the chloroplatinates (1) are readily soluble (sodium and lithium), or (2) are comparatively insoluble (potassium, rubidium, and caesium).

Minerals and Ores

Although the minerals from which caesium, rubidium, and lithium may be extracted are distributed rather widely in nature, the known minerals and deposits rich enough to furnish large supplies are few. Most of the minerals contain at least a trace of all three elements. Several minerals comparatively rich in lithium are known, but only one (pollucite) is high in caesium, and no definite rubidium minerals are known. Lepidolite, the best known of the lithium minerals in a number of localities carries from a trace to more than 3 per cent. of rubidium oxide (Rb_2O), and a small fraction of a per cent. of caesium oxide (Cs_2O). Lepidolite, in fact, carries more rubidium than any other known mineral, although on very incomplete data a tiny specimen of a rubidium mineral, rhodozite, from the Urals has been described.

The principal lithium minerals are lepidolite, amblygonite and spodumene. Sundry other minerals, notably petalite, ($L_2O.Al_2O_3.4SiO_2$) and triphylite ($LiFePO_4$] with some manganese) and the grades to lithiophilite ($LiMnPO_4$] with some iron) contain considerable percentages of lithium and may contain very small quantities of rubidium and caesium, but the total amounts available are too small for them to be of importance as a source of lithium. All the minerals named are found in pegmatites. Lithium has been found in more than 40 other minerals in quantities ranging from spectroscopic traces to more than 9 per cent. (the last in a mica), but none of the minerals is important as a possible source of lithium under present known conditions.

Tests for Identification

Caesium and rubidium, being similar to potassium, may be precipitated as platinic chlorides ($CsPtCl_6$ or $RbPtCl_6$). These precipitates, which are much more insoluble than the corresponding potassium compound, precipitate in a more finely divided condition, and the caesium salt has a paler colour. For positive identification it is best to heat some of the precipitate on a platinum wire and examine the flame with a spectroscope.

The crimson colour that lithium imparts to a flame usually serves for its identification. The colour of a pure lithium flame is nearly monochromatic, showing when examined with the spectroscope one bright crimson and one very faint yellowish-red band. Sodium has a disturbing influence, but this is mitigated by the fact that lithium is more volatile than sodium. When, therefore, the assay is first introduced into the flame the red of lithium will show before the yellow of sodium; and when the flame is strongest, if the position of the assay is changed to where the heat is less intense, the yellow will disappear first and the red of lithium will be seen distinctly. When the proportion of sodium is large, however, the spectroscope must be employed.

Uses

Caesium and rubidium appear on the market as salts, mainly chlorides, nitrates, and hydroxides, and only rarely in their metallic state. There has been little demand for caesium. The principal use at present is in the manufacture of radio tubes. The caesium is introduced into the tubes in the form of chloride, mixed with magnesium or calcium, and is compressed into small tablets or "pills"; at one stage in the manufacture of the tube the pill is flashed, eliminating the last trace of air and thus securing the desired vacuum. The caesium chloride supplies positive ions at the surface of the filament.

Both caesium and rubidium are employed to a limited extent in the manufacture of photo-electric cells. Rubidium, however, appears to be more suitable for this than caesium, because an extremely thin layer can be applied on the inner side of the glass. In the manufacture of these cells the metal, either caesium or rubidium, is introduced in excess, but later is removed entirely except for the molecular layer that has formed on the silver or other base-metal electrode. The photo-emission of the molecular layer of metal is greater than that of the massive metal.

Rubidium compounds are employed in larger amounts than the metal because they have proved their importance as reagents in microchemistry; their ability to form crystalline compounds readily, makes them of great value in this important and rapidly developing field. Unlike caesium and rubidium, lithium minerals are used both as they occur in nature and as sources of lithium salts and compounds. One of the earliest uses for lithium salts was in the manufacture of lithia water and other medicinal preparations, but the use of lithia water has declined rapidly in recent years. The carbonate, phosphate, nitrate, and organic compounds are used for medicinal purposes.

At present the largest use for lepidolite is in the manufacture of opal glass. It is ground and added, either fused or unfused, to the glass batch. Lepidolite to be used in glass-making must be free from tourmaline and other possible colouring materials. Patents cover the use of the mineral for this purpose. In pyrotechnics, lithium chloride is used to impart a crimson colour to fireworks and signal lights. Fairly large quantities of several of the compounds of lithium are used in other ways. For example, lithium hydroxide is used in alkaline electrolyte storage batteries, lithium bromide and iodide are employed in photography, and lithium carbide is used in Rontgen-ray experiments.

Lithium metal, as such, has no known use owing to its softness and rapid deterioration by water, but in recent years considerable research has been made to determine the possibilities of alloying lithium with other light metals such as beryllium and aluminium.

Aluminium to which a very small percentage of lithium has been added has been used to a limited extent in Germany for trucks and bed frames of street and railway cars. This alloy is exceptionally strong. Since lithium oxide has a low fusion point, lithium has been suggested as a deoxidiser of copper.

Deoxidation of Steel

Lines of Research

STEEL making consists, essentially, in putting pig iron, scrap, and ore into a shallow vessel and melting. When melted, the "heat," as it is called, is in an impure state, the most important foreign ingredient being carbon. In order to remove carbon the steel-maker adds iron oxide, carbon being removed as the gaseous carbon monoxide. In order to stop the elimination of carbon, the steelmaker must generally introduce "deoxidisers," other elements which react more vigorously with iron oxide than does carbon. Those most commonly used are silicon, manganese, or aluminium. The result of their addition is that instead of carbon monoxide, silica, manganese oxide, or alumina is formed as dispersed particles in the molten steel.

This procedure is, although economically justifiable, more or less harmful to the finished product. Various flaws and defects can be traced directly to the microscopic particles of oxides resulting from the deoxidation. In certain cases, however, it is possible to eliminate them more or less completely from the liquid steel, and this question is now the subject of intensive research.

"Inclusion" Study

Two lines of attack are being followed. The first is mainly from a laboratory standpoint. In this work steel is made containing the various "inclusions," as they have come to be called. Research men thus learn to identify and classify the particular types, using high-power microscopes and other special methods. The chemical reactions which lead to their formation are also investigated as an aid in fixing the amount of inclusions to be expected from the addition of a certain deoxidiser under given conditions. Further valuable information is obtained in this way concerning the behaviour of the inclusions after formation. Of the utmost importance are the answers to the questions: "Is the inclusion solid or liquid?" and "Will it combine readily with other inclusions?" The properties of the inclusion itself determine to a large extent its chances of escaping from the steel.

The second phase of the inclusion study follows closely upon the first. This is carried out on full-size open hearth furnaces, where metallurgists follow the working of heats, taking frequent samples and observations. When the heat is nearly finished, a deoxidiser is added, and its effect on the steel is noted. The samples taken reveal the action of the deoxidiser and chemical methods indicate the relative "cleanliness" of the steel. In this way various deoxidisers and combinations of deoxidisers are being studied—the main object being to produce sound steel with a minimum of inclusions.

Analysis of Steel for Manganous Oxide

Whenever steel is deoxidised with manganese, or manganese-bearing alloys, a certain amount of manganous oxide is formed and may remain in the steel as a complex inclusion with ferrous oxide, silicon dioxide or sulphides, or in the uncombined condition. Investigation of this phase of the deoxidation problem is, however, greatly retarded by the lack of a suitable analytical method for inclusions whose chief constituent is manganous oxide. These are characterised by their extreme solubility in acids, however dilute. Hence the Dickenson method, useful in analysis for inclusions which are mainly silica, where the steel is removed by solution in acids, is out of the question.

Recent experimentation has shown that electrolysis may be substituted for the acid solution process with considerable saving in time and with good recovery of the manganous oxide present in the steel sample. In the method in its present stage of development the sample is used as the anode in an electrolyte of ferrous sulphate. By the passage of current through the solution the iron is "plated" out on the cathode and the inclusions fall to the bottom of the container as a slime. It is essential that the iron plate out in a solid adhering layer to avoid contamination of the residue by metallic iron and that oxidation of ferrous salts in the solution be prevented.

Pickling in Iron and Steel Industries

The Latest Mechanical Methods

IN the engineering world many operations of a chemical or chemical engineering nature have to be carried out, of which the "pickling" of metals with dilute acid for cleaning purposes is an important example. Thus, brass is treated with dilute nitric acid so as to give a perfectly clean surface before lacquering, whilst an extensive operation is the pickling of iron sheets with dilute sulphuric acid. In the latter connection, hand methods are now rapidly becoming obsolete, and there is being adopted almost completely mechanical methods for the bulk handling of the material, including the use of special cranes and pickling gear.

The net result, as compared with hand methods, is a great reduction in total costs, as much as 6d. per ton for handling alone, the only manual labour involved being that of charging the sheets into the heavy metal "baskets" or containers. All the rest, picking up the baskets, lowering into the dilute acid tanks, lifting out again, rinsing in water, and discharging the clean sheets from the basket, is carried out by an electrically operated overhead crane.

One firm prominent in this field are Craven Brothers (Manchester), Ltd., Reddish, Stockport. A recent installation they have supplied to a well-known British steel works consists of ten pickling machines, in two sets of five, each machine having a capacity of 48-50 tons per 24 hours of 10 ft. sheets of medium gauge. Also each installation of five machines is operated by a pickler and one crane driver and the above output, with hand pickling and handling, formerly required the labour of 14 men. The pickling tanks are of concrete on massive concrete foundations, lined with acid resisting material faced also with acid-proof brick, not affected by the wash of the liquor.

The special overhead crane used for carrying and lifting in and out of the pickling tanks and washing tanks the heavy baskets filled with sheets, is a modification of the well-known Craven "Octopus" overhead travelling grab crane, provided with a special automatic drip tray. When the basket has attained the highest position after lifting out of the tank, this drip tray automatically comes into operation, moving underneath and catching all the drippings. Also the baskets used are of a heavy and robust type with special support pads for the sheets so as to prevent any damage to the thinner qualities. These "Octopus" overhead grab cranes are particularly suitable for the iron and steel industries, especially sheet mills, warehouses and other establishments, where sheets have to be handled in bulk, whilst a whole series of cranes of different types are made at Reddish, many of which are of great interest to the heavy chemical as well as the metallurgical industries.

Metallurgical Topics: Monthly Notes and Comments

From Our Own Correspondents

Iron and Steel Institute

At the annual meeting of the Iron and Steel Institute, which concluded on Friday (yesterday), the number and quality of the papers compared very well with those presented on previous occasions, and more of them than usual were of the type of practical utility that chiefly appeals to the bulk of the members. The Report of the Council was satisfactory, and an increase in membership is recorded which, in view of the deep depression that has so long prevailed in the iron and steel trades of this country, is no mean achievement. On the first day of the meeting two presentations were made of the highly prized Bessemer Gold Medal of the Institute. One was to Mr. Eugene Schneider, the well-known French ironmaster and a past president of the Institute; the other, which will be still more generally acclaimed by metallurgists, to Dr. Walter Rosenhain, whose name is a household word wherever metallurgy is pursued. The recognition of the value, to the science of iron and steel, of Dr. Rosenhain's work at the National Physical Laboratory confers honour on the Institute itself.

One other point of interest in connection with the meeting arises from the resolution respecting the term of office of presidents. This, some years ago, was altered from two years to one year, but is now to revert to the earlier extended period. One-yearly presidencies are all too short to enable the chief officer of an institute properly to make himself acquainted with the workings, and moreover hamper that continuity of policy so desirable when the chair is occupied by a really devoted official. Last, but not least, presidencies of one year's duration use up too rapidly the prominent men on the Council eligible for the appointment, while, once past the chair, interest in the institute and its affairs is apt to wane—however faintly.

Alloys of Iron with Silicon

Of the papers themselves probably the most interesting and important from the point of view of the scientific metallurgist, is that by Dr. J. L. Haughton and Dr. M. L. Becker, embodying research work at the National Physical Laboratory, undertaken under the auspices of the Alloys of Iron Research Committee, and the direction of Dr. Rosenhain. It is the ninth report of a series, and deals with "The Constitution of the Alloys of Iron with Silicon." Both iron and silicon of exceptional purity were employed (Fe 99·99, and Si 99·97 per cent., respectively; O not recorded). Silica pots were used for melting the alloys, as preliminary experiments in which alumina pots were used showed a very high degree of aluminium contamination (up to nearly 2 per cent. Al). The diagram of the resulting iron silicon system has been most carefully plotted and reveals, in the solidification area, an alpha solid solution region and an epsilon area, both involving the formation of eutectics, that with the epsilon phase (the compound Fe Si) occurring at 1195° C, and that with the zeta phase (probably the compound Fe_2Si_5) at 1213° C. The transformations in the solid phase have also been worked out. This comprises an investigation of the alpha-gamma transformation zone, but part of the diagram is still in an unsatisfactory state. Two magnetic transformations have been, however, established and the authors draw attention to the fact that it is not a little remarkable that, in the case of alloys of iron with carbon, phosphorus, sulphur, and silicon, a magnetic transformation has been found to occur in the inter-metallic compound most rich in iron (Fe_3C, at 215° C; Fe_3P, at 420° C; FeS, at 296° C; and Fe_3Si_2, at 82° C.). Possibly, they suggest, further investigation would show that it occurred in all such compounds.

"Practical Papers"

From the practical point of view two papers on the perennially interesting subject of the chromium-iron alloys were read, one by Dr. Rosenhain and Mr. Jenkins, on "Some Alloys for Use at High Temperatures—Nickel Chromium and Complex Iron Nickel Chromium Alloys" (carried out for the Engineering Coordinating Research Board, and for the Department of Scientific and Industrial Research), and one by Mr. J. A. Jones of the Research Department, Woolwich, on "Chromium Copper Structural Steels." In regard to the former, one of the specimens investigated, described as No. 183 (which had the following composition; 30·15 per cent. nickel; 28·55 per cent. chromium; 35·00 per cent. iron; 3·79 per cent. tungsten; 1·34 per cent. carbon and 1·05 per cent. silicon) was found to have a tensile strength of over 30 tons per sq. in., at 800° C., and as cast material possessed likewise the highest tensile strength of any of the chill-cast alloys at atmospheric temperatures. The relation of none of the alloys tested at 800° C., under prolonged stress, to short-time tensile strength is at all certain, and alloys tested at different high temperatures would probably be found to bear different relationships to the stresses they could withstand at ordinary temperatures. Nevertheless, the experiments indicate many directions in which steels and alloys of existing types could be improved by the carefully controlled addition of other elements.

In regard to structural steels, Mr. Jones finds that the addition of manganese to steels containing chromium offers no advantage over the use of high manganese steels not containing chromium. Within the range of the materials investigated the best results were found associated with a steel which contained copper in addition to small amounts of carbon, manganese, and chromium (0·3 per cent. of carbon; 0·9 per cent. of chromium; 0·5 per cent. of manganese, and 1·2 per cent. of copper). Such a material compares, in mechanical properties, favourably with the best manganese-silicon structural steels, and is better than those obtained with structural steels containing manganese only.

Steel in Ancient Egypt

Not the least interesting of the papers was one by Sir Henry Carpenter on "The Metallurgy of Some Ancient Egyptian Implements." The archæological aspects of metallurgy have been receiving increased attention of late; it will be remembered that Dr. T. A. Rickard contributed a paper on an allied subject at the recent meeting of the Institute of Metals. Sir Henry Carpenter raises the question of whether the ancient Egyptians were acquainted with the method of carburising iron to the extent of being able to make what would practically be steel tools, and with the art of tempering them. He puts forward and maintains, with some very careful and well considered evidence, the thesis that both the mode of carburising and the effect of quenching were known to them even as early as 1200 B.C., but that tempering was a later art and was introduced by the Romans. Yet some degree of what is understood by heat treatment was likewise known before. The Iron Age in Egypt did not, however, properly begin until the technique of carburising and heat treatment generally had been discovered and well developed, or, to put it differently, it was not until iron had been converted into steels that the Egyptians obtained a range of alloys that were superior in their properties to the bronze with which they had, much earlier, become acquainted.

Research on Soft Solders and Soldered Joints

A very welcome departure is being made by that admirably managed body, the British Non-Ferrous Metals Research Association. Hitherto the reports of the investigations carried out by it have been issued only to subscribing members, although from time to time some have been "liberated" for general use, by being communicated through societies and institutions such as the Institute of Metals, or the Faraday Society. Now, although subscribers will naturally have the first call on the results obtained, certain reports will from time to time be issued for general circulation, and will be purchasable by anyone interested in the subjects dealt with. A very fine and comprehensive research of this kind, dealing with the jointing of metals, has for some time been in process, and Part I, on "Soft Solders and Soldered Joints," has just been issued, from the offices of the Association at Temple Row, Birmingham. It deals with the "hereditary" lead-tin solders and with lead-antimony, tin-antimony, and lead-tin-antimony alloys. It has, moreover, chapters devoted to the physical properties of the solder alloys, the strength (in shear) of soldered joints and the factors upon which it depends, the "metallurgy" of a soldered joint, and the corrosion resistance of such joints, ending up with a number of eminently prac-

tical considerations as to the choice of a solder for various types of work, and a note on the tinning of iron. The treatment of the subject is comprehensive and only one aspect or it is omitted, and that for good and sufficient reasons. This is the problem of the soldering of aluminium, which might be, and probably is being, made a separate investigation entirely. The report is well produced and contains a large number of clear diagrams relating to the alloy systems of the alloys described.

The Welding of Copper

UNTIL recent years it was considered that the satisfactory welding of copper was an impossibility. The high thermal conductivity of the metal gave rise to grave practical difficulties, and even if these were overcome it was found that the copper became brittle by the action of the gases in the acetylene flame. With the formation of Imperial Chemical Industries, Ltd., technical authorities who were interested in copper welding from three different points of view came together. They were :—chemical manufacturers, who required welded copper vessels ; copper manufacturers, who were naturally anxious to see copper placed on the same footing as the majority of other metals, as far as welding is concerned ; and experts in welding processes generally. As the result of research work carried out by these three groups in collaboration, a process for welding copper has now been evolved which renders the operation simple and safe, provided the correct materials are used.

A demonstration of this welding was carried out by the Premier Electric Welding Co., Ltd., on Tuesday, April 29, at the Swansea works of British Copper Manufacturers, Ltd., a subsidiary company of Imperial Chemical Industries. At this demonstration copper pipes were welded together without difficulty and the joint subjected to severe flattening and bending tests, the results of which proved conclusively that the weld would withstand conditions of service as satisfactorily as the pipe itself. Sheets of copper were also joined together by the welding process, and it was shown that these would withstand a considerable amount of work and stretching ; in fact, as much as the solid copper itself could be expected to withstand. The welding of varnish pot seams was also demonstrated, a process which eliminated a great deal of troublesome riveting. It was observed that the welding operator worked quickly and as easily as if he were merely brazing the pieces together, and after the weld had been made and trimmed it was difficult to see where the joint occurred, whilst it had a tensile strength equal to that of rolled copper.

Difficulties Overcome

THE demonstration proved that the difficulties previously associated with the welding of copper had been overcome, and it is certain that there is a wide field in industry for the application of the process. Riveting will be largely eliminated, and vessels which previously had to be forged out of solid copper—a very expensive procedure—can now be built up by welding sections together. All this has been achieved by means of slight modifications in the technique of welding ferrous metals, by the use of copper alloy filler rod and flux of the appropriate type. The copper that has been developed for welding purposes is not attacked by the gases of the acetylene flame, and it is essential to use this copper if the weld is to be perfectly satisfactory. The copper is a modification of the tough pitch variety, supplied at the same price, but not inferior to it in any way, in fact, it might be expected to give better service generally. The filler rod, again, is of specially modified copper, which is very fluid when molten, and so runs well into the joint, leaving no air locks or gaps. It is essential to use this filler rod in order to obtain a homogeneous weld. The flux is used in order to hinder the formation of scale on the red hot copper, as the scale prevents good metallic contact from being obtained. Using these materials, which are supplied by Imperial Chemical Industries, Ltd., it was demonstrated that with an hour's practice a welder could acquire the technique of copper welding and produce sound joints as easily as he could with ferrous materials.

Cobalt Production

WHILE Canada formerly produced a much larger part of the world's output of cobalt than is at present the case—her proportion has now dropped to about 55 per cent. of the world's total—experimental work in selective flotation indicates that this method of recovery may be applied to low grade deposits that have not as yet been mined, and if it proves to be successful the industry may be given a new lease of life. In Canada cobalt is obtained from the arsenical cobalt-nickel ores of Ontario ; the other chief world source of cobalt is the Belgian Congo. A reported new use of cobalt is in the application of cobalt-tungsten-carbide alloys in the manufacture of cutting tools. The cobalt in these alloys gives increased strength and prevents oxidation when the tools are operated at such high speed that the cutting edges become red hot. Stellite, a cobalt-tungsten-chromium alloy is also coming into much more general use not only for cutting tools but more particularly for depositing on surfaces subject to great wear, as, for example, on grizzly bars and on machinery parts subject to wear.

Expansion of Large Canadian Plant

ACCORDING to the annual report of the Consolidated Mining and Smelting Co. of Canada, Ltd., which is published at Montreal, the company experienced a decrease in its total production of metals last year, though that of zinc increased. The output included : Lead, 300,433,924 lb. ; copper, 8,346,632 lb. ; gold, 14,694 oz. ; zinc, 172,096,841 lb. ; cadmium, 773,976 lb. ; silver, 7,362,164 oz. Comparative figures for 1928 are as follows : Lead, 318,831,578 lb. ; copper, 17,806,306 lb. ; gold, 23,632 oz. ; zinc, 163,530,980 lb. ; cadmium, 491,894 lb. ; silver, 7,673,762 oz. There has been during the year a growing production of cadmium, which is becoming an important item in the wide range of products at the great metallurgical plant at Trail, B.C. The production of bismuth on a commercial scale began during the year, and the sulphuric acid production is finding a market. An additional sulphuric acid plant with a daily capacity of 335 tons has been authorised, together with the first unit of an ammonia plant with a daily capacity of 47 tons estimated to cost $7,500,000. Reference is made in the report to the coming erection of a zinc refinery by the company in conjunction with Ventures, Ltd., the site chosen being the Ile Perrot near Montreal.

Prize for New Uses of Mercury

A PRIZE of £5,000 is offered by the European producers of mercury to whoever proves to a commission, consisting of the president and vice-president of the producers and two technicians named by the Spanish Academy of Sciences and the Academy of Italy, to have found a new use for mercury or its salts and to have industrially exploited it. The use should be as yet unknown to the industry and should be regularly and definitely protected by patent not before January 1, 1930, in Germany and the United States. Its application must be important enough to indicate a new consumption of mercury of at least 1,000 flasks during 1930, 3,000 in 1934, and 5,000 in 1935. The complete account of the studies and practical experiments relating to the new application should be presented in quadruplicate, printed or typewritten either in Spanish, Italian, German, English, or French, and should be sent, registered, to Mercurio Europeo, Bureau de Repartition, Plaza St. François 5, Lausanne, from which further information may be obtained.

Tin-Base White Metal "B"

THE fourth of the series of non-ferrous standard analysed samples is now ready for issue. The analysis is as follows :—Tin, 84·0 ; antimony, 7·52 ; copper, 4·03 ; lead, 3·86 ; zinc, 0·40 ; iron, 0·05 ; arsenic, 0·04.

For many years non-ferrous chemists have wished to have a standard of this kind to guide them in the analysis of tin-base bearing metals on account of working to specifications, confirming the quantity of the high priced metals in the alloy, and settling disputes. The analyses have been made by twelve chemists experienced in testing this class of alloy. The list includes a Government Department as well as several referee chemists, manufacturers, and users. An important feature of the certificate of analysis is the outline of the methods used by different chemists. The standard is available to anyone at a price based on ultimately covering the cost of preparing and issuing it. The three usual sizes, viz., 50 grm., 100 grm. and 500 grm. bottles are provided together with certificate and methods with each sample. Further particulars may be obtained from British Chemical Standard Headquarters, 3, Wilson Street, Middlesbrough.

Trade, Commerce, Finance: The Month in Review

From Our Market Correspondent

THE Budget which was to have such a fateful influence on British industry is now known, and already the agitation which some of its provisions aroused has died away. As far as it affects the iron and steel trade particularly, it has no outstanding features. The motor car trade is left to enjoy the benefits of the McKenna duties for the present, although that protection will come to an end if the Government remains in power long enough. The cutlery manufacturers are to be deprived of the protection against foreign imports, this change coming into force very soon. There has been a great outcry in the Sheffield district against the decision, and alarming pictures have been drawn of the deplorable results to be expected from an inrush of cheap foreign cutlery. It is a waste of breath. So long as Mr. Snowden remains Chancellor of the Exchequer he will maintain the position he has taken up, and the best thing that the manufacturers can do is to devote their energies to the preservation of their trade in spite of the added difficulties. The Chancellor's main provision, the raising of additional revenue by an increase in the income tax, adds a little more to the burden which all industries have to carry. It is a very unwelcome change, as it comes at a time when trade is suffering from a severe depression. There will need to be a marked change in the state of trade if the forecasted yield from the increased tax is to be realised.

World-wide Depression

The Budget provisions have shown little or no effect on trade. There is certainly no improvement; and although it is rather early to make a prediction, there does not appear to be any immediate revival in the motor industry, which was to be made or marred by the Budget. Indeed, one is forced to the conclusion that the slump in trade is more general, and its causes more serious than can be explained merely by the Government's money-raising schemes, anticipated or known. The depression is not only national but international. From Belgium, Germany, and France comes the same story of unfavourable conditions; and even the United States can see the end of the boom which they have experienced. Competition becomes keener and keener between the rival nations. When one hears of the Belgian steel makers supplying steel plates to South America at £7 5s. per ton delivered, one can realise the seriousness of the position. At a time like this the position of the Continental Steel Cartel becomes increasingly difficult. There is almost certain to be a further decrease in output, a step which will intensify the troubles of the makers. Altogether, the situation is very doubtful, and we are sharing in a world-wide depression.

More Orders or Less Plant

One of the worst features is the absence of any indication that the clouds are likely to lift. It is disheartening to have to repeat the same cheerless story month after month, and still more so to contemplate a continuance of like conditions. That is what we have to face. The coming months will sharpen the anxiety of those who are responsible for carrying on the steel trade of this country. The struggle for orders will become keener and prices will tend to fall. There is some little consolation in the fact that the full benefit of the derating proposals will be realised this year, but that is a very unsatisfactory sort of prop for the steel trade. What is wanted is more orders to keep the mills running, or a reduction in plant so that the orders available will provide continuous work. The time is most opportune for the launching of the Bankers' Industrial Development Company, which has just been formed to finance schemes of industrial rationalisation. It has the support of the banks and will provide the money to carry out approved schemes for the rehabilitation of industry. It is probable that one essential condition on which assistance can be obtained will be that the applicant shall undertake to combine with other similar undertakings, and then shut down surplus plant so as to avoid wasteful competition. The object is a most desirable one. If trade conditions persist as they are at present, of which there is every probability, it looks as though the new company will soon be in action.

Stainless Steel Agreement

Some interest has been aroused by the terms of the agreement which has been renewed between the Firth-Brearley Stainless Steel Syndicate, of Sheffield, and Krupps of Essen. The object is to prevent competition in stainless steel between the two countries. The parties agree not to invade each other's home markets, and probably there is an understanding also in respect of outside markets. The two concerns control practically the whole of the stainless steel production in the two countries and most of the overseas manufacturers work under licences from them. The use of stainless steel in various qualities is extending, and it holds out great possibilities for the future. The chief obstacle to its more general use is the high price, but as time goes on the cost of production will be reduced, particularly if the attempts which are now being made to produce the steel in bulk in the open-hearth furnaces is successful.

Lengthy Easter Closing

Local conditions have been rather upset by the Easter holidays. In busy times the stoppage is confined to two days, but with the present slackness in trade most works have taken the opportunity to close down for a longer period, in some cases up to a whole week, in the hope of accumulating a sufficient weight of orders to give a good start. Business has hardly settled down since the stoppage and markets generally are slow. The pig iron market has not shown any renewed activity. In the Cleveland district the ironmasters are able to dispose of their limited output, but they are not too sure of being able to maintain either prices or production. The effect of their recent cut in price seems to have worn off, and buying is again limited. The Midland pig iron makers have not followed the Cleveland example. The Central Pig Iron Producers' Association at their meeting on April 24 made no change in the price of foundry iron, the reason given being that the high cost of production did not allow any reduction in the selling price. It is expected that this decision will lead to more buying from the foundries, who have been waiting for this meeting. A slight reduction has been made in forge iron but there is not much business in this quality. The basic pig iron makers are still continuing their efforts to form an association for the control of prices and production, but there are difficulties in the way of making this a national association which have not yet been overcome. One chief purpose of the movement is to control the imports of Indian pig iron. Although the quantity being imported is not large in comparison with the home production, it is sufficient to disturb the market. The quality is very good and the price is some shillings below the home price, the result being that the home price is being forced down to the same level. At present the demand for basic iron for the steel works is very poor.

Steel Markets

There is nothing of importance to report about the steel markets. In all sections business is very quiet. Semi-finished steel has fallen to the same condition as finished steel, and the tendency to cut prices for billets is more marked. There is not much buying of Continental billets, although the merchant importers of this steel are busily canvassing prospective buyers. The controlled prices for plates, sections and joists remain unchanged. There is a further tendency to weakness in the uncontrolled prices. The small bar trade may improve somewhat when the motor car trade gets into its stride, but just now it is by no means good; while the prices at which orders are taken are in many cases quite unprofitable. The adverse conditions which have prevailed for so long have turned the steel makers more and more to the special qualities, but as was to be expected these have now become subject to such competition that there is little margin of profit in them.

The production of pig iron in March amounted to 665,800 tons, compared with 607,000 tons in February, there being five less furnaces in blast. The output of steel was 826,100 tons, compared with 776,400 tons in February.

Some Inventions of the Month

By Our Patents Correspondent

Abstracts of other Patents of metallurgical interest will be found in our Patent Literature, published weekly in THE CHEMICAL AGE.

Alloys

METHODS of production of beryllium alloys, particularly such as have a high beryllium content, by electrolysis of molten baths are described in Specification 325,762, bearing the International Convention date November 13, 1928, by Siemens und Halske Akt.-Ges. of Siemenstadt, Berlin. The alloying metal is introduced into the bath by anodic solution. One or more cathodes, which may be cooled, dip into the bath from above, and the bottom of the crucible is connected as anode. The specific gravity of the alloying metal must be such that, when introduced as powder or filings in successive small quantities, it sinks in the bath and is anodically polarised on reaching the bottom. The temperature should be below the melting point of the metal, and the amount of metal added should not be such as to make the specific gravity of the deposited alloy exceed that of the bath. A mixture of the fluorides of beryllium and of one or more alkaline earth metals is specified as electrolyte, alkali metal halides being added, if necessary, to reduce the specific gravity. Methods are described in detail for the production of an alloy containing 15 per cent. of copper, one containing 35 per cent. of nickel, and one containing 3 per cent. of iron. Others obtainable are one containing 50 per cent. of copper, alloys with the heavy metals, and a copper-nickel-beryllium alloy.

COPPER-NICKEL alloys containing 65–75 per cent. of copper, 18–22 per cent. of nickel, 5–15 per cent. of zinc, 0·01–0·2 per cent. of aluminium, 0·01–0·2 per cent. of magnesium, 0·01–0·08 per cent. of silicon, 0·01–0·2 per cent. of manganese, and 0·01–0·1 per cent. of cadmium are described in Specification 325,131, bearing the International Convention date November 3, 1928, by C. Philippossian, of Geneva, Switzerland. The alloys are obtained by melting together copper–nickel and copper–zinc alloys, and adding in succession copper–manganese, copper–silicon, aluminium, magnesium, and copper-cadmium.

Aluminium

A METHOD of working aluminium in deforming a crystalline aluminium body is described in Specification 324,900 (Dicker), a communication from Naamlooze Vennootschap Philips' Gloeilampenfabrieken, of Eindhoven, Holland, dated August 1, 1928. The degree of deformation is so chosen that subsequent heating until recrystallisation is complete causes the material originally belonging to a single crystal to reassume a single crystal form. The operation is repeated until the deformation is sufficient to give the required shape. The rolling of a rod of aluminium to about one-fourth of its original diameter, followed by heating to about 600° C. for 20 mins., is specified.

Annealing Furnaces

STEEL or other castings are cooled in an annealing furnace at the termination of the heating operation by air which is rapidly blown or sucked through the hollow stationary or movable hearth. The castings are supported on a horizontal metal grating placed on the hearth which is composed of refractory blocks each provided with a horizontal and a vertical passage for the air current. See Specification 325,307, dated November 26, 1928, by G. Herrmann and L. Zerzog, of Neubiberg, Munich, Germany.

Heat Treatment of Metals

A METHOD of reducing, or preventing the formation of, oxide coatings on metallic goods under treatment in an electric or other furnace is described in Specification 323,496 (Sadler), dated June 29, 1928, a communication from American Mond Nickel Co., of Pittsburg, U.S.A. The treatment is effected in an atmosphere comprising a mixture of nitrogen or other inert gas and hydrogen, the hydrogen content being so low (2-15 per cent.) and the volume of gas supplied being so predetermined that, during the deoxidation of the goods, substantially the whole of the hydrogen is used up. Thereafter the goods are cooled down in the atmosphere thus substantially deprived of hydrogen.

Ingot Moulds

A MATERIAL for use in forming or repairing heads or linings of ingot moulds or for joining sectional heads is prepared from sulphite liquor and clay. In forming heads and linings the sulphite liquor may be replaced by glucose or peat extract and sawdust, sand, coke breeze, or burnt brick may be added. See Specification 325,303, dated November 22, 1928, by G. W., J. F., W., and C. E. Naylor, of Denby Dale, Huddersfield.

Melting Metals and Alloys

To enable the heating or melting of metals or alloys in an induction furnace of the customary ironless type to be effected by currents of low frequency the material is subjected to a preliminary treatment to increase its conductivity. Such treatment may be a chemical, *e.g.*, an electrolytic, treatment, or in the case of very finely divided material mechanical pressure may be applied with or without a supplementary chemical treatment. As an example of an electrolytic treatment the removal of oxide from chromium by immersing it as a cathode in acid is specified. See Specification 325,940, dated January 7, 1929, by C. Tama, of Berlin, and Electric Furnace Co., Ltd., of London.

Treatment of Ores

A PROCESS for the treatment of ores to facilitate concentration preparatory to extracting precious metals is described in Specification 323,466 (Mellersh-Jackson), dated August 29, 1928, a communication from G. Bürg, of Berlin. The ore, containing the metal in finely divided substantially colloidal form is heated to such an extent and under such conditions that the metal is rendered more amenable to further treatment without causing it to combine chemically with other constituents of the ore. The heating may be effected in an oxidising or reducing atmosphere, and the temperature employed is necessarily below the softening point of the material.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

Mortgages and Charges

[*NOTE.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case, the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.*]

BALDWINS, LTD., London, E.C., steel manufacturers.—Registered April 4, Trust Deed dated March 24, 1930 (supplemental to Trust Deeds dated July 4, 1891, etc., securing £2,250,000 debenture stock reduced in pursuance of a scheme of arrangement to £1,206,850 " A " debenture stock) ; charged on properties comprised in the schedules to the filed particulars, etc. *£3,810,354. May 10, 1929.

BIRTLEY IRON CO., LTD.—Registered March 25, series of £30,000 2nd debentures (subject, etc.), present issue £10,000 ; general charge. *£40,000. February 12, 1930.

GALLOIS LEAD AND ZINC MINES, LTD., London, E.—Registered March 15, £1,700 debentures part of £20,000 ; general charge (excluding plant, etc., where purchase price is not fully paid).

LAGARES TIN MINES, LTD., London, E.C.—Registered March 18, £4,000 debentures part of £37,500 (not ex.) ; charged on certain shares, etc., also general charge. *Nil. April 3, 1929.

LAKE GEORGE METAL CORPORATION, LTD., London, E.C.—Registered April 2, series of £350,000 notes, and premium of 10 per cent., present issue £100,000 ; general charge.

Satisfactions

ALUMINIUM CORPORATION, LTD., London, W.C.—Satisfaction registered April 2, £150,000, part of £500,000, registered July 3, 1925.

BOLCKOW VAUGHAN AND CO., LTD., Middlesbrough, ironmasters, etc.—Satisfaction registered April 5, £322,000, registered October 19, 1925.

Monthly Metallurgical Section

Published in the first issue of "The Chemical Age" each month.

NOTICE.—Communications relating to editorial matter for our Monthly Metallurgical Section should be addressed to the Editor, THE CHEMICAL AGE, *Bouverie House, 154, Fleet Street, London, E.C.4. Communications relating to advertisements and other business should be addressed to the Manager. Contributions will be welcomed from correspondents on any points of interest to metallurgists bearing on works practice or current research problems.*

Metallurgical Research during 1929

Work at the National Physical Laboratory

The following extracts are taken from the report of the Superintendent (Dr. W. Rosenhain) on the work of the Department of Metallurgy and Metallurgical Chemistry at the National Physical Laboratory during 1929. The complete report on the year's work of the laboratory has just been issued by the Department of Scientific and Industrial Research (H.M. Stationery Office, 298 pp., 11s. net).

DURING the past year, writes Dr. Rosenhain, the Department has carried out work in continuation of the programme of the previous year. It has not been possible to commence new investigations, but new problems have developed in connection with a number of the investigations in progress, and some of these questions have been pursued. Investigatory test work, relating to cases of failure in engineering service, manufacturing difficulties and similar questions, has been carried out, and reports on a number of interesting and important cases have been issued.

Physical Structure of Metals and Alloys

A number of problems relating to the general physical structure of alloys have been investigated. These mainly turn upon the structure and constitution of intermetallic compounds as compared with solid solutions. In this connection, special interest attaches to the more complex types of lattice structure which have been found in certain ranges of the copper-tin, copper-aluminium and other alloy systems involving unit cell structures containing upwards of 50 atoms. A structure very similar to these has also been found in α-manganese. An attempt to explain these complex structures on the basis of a relatively simple assumption, namely, that these bodies form associated molecules whose shape, in the solid state, does not lend itself to close packing in a simple lattice, has been put forward by the Superintendent in an address delivered to the Deutsche Gesellschaft für Metallkunde at Düsseldorf in September. This view suggests that, in these complex structures, certain of the atoms play a similar part to that performed by molecules of water when they act as water of crystallisation in the formation of many inorganic crystals. The idea follows that in complex compound crystals of this type, the atoms which constitute this "metal of crystallisation" may be replaceable by atoms of the other component, whereas the atoms forming the molecule of the compound proper should not be thus replaceable. This affords an explanation of the moderate range of solid solubility which is known to exist in such compounds, while in other compounds which form regular lattices of a simpler type, solid solubility seems to be either non-existent or extremely limited. A detailed investigation of the two copper-aluminium alloys containing 16 per cent. and 19 per cent. of copper has been undertaken with the object of attempting to ascertain the positions occupied by solute atoms of copper in the structure of the γ-constituent of these alloys The experimental results from both Laue and oscillating crystal photographs show that differences exist in the X-ray spectra of the alloys which may make it possible to determine the position of the atoms in the large cubic unit of the structure. When such measurements can be made it will be possible to test the correctness of the hypothesis outlined above.

Intermetallic Compounds

In connection with the study of the nature of intermetallic compounds, some recent German work suggests that the elastic properties of these bodies may be markedly different from those of their constituent elements, and also from those of solid solution crystals of adjacent composition. The study of the elastic properties of intermetallic compounds, however, is rendered very difficult by the fact that in the majority of cases they are hard, brittle bodies which cannot readily be formed into test-pieces suitable for the measurement of elastic deformation. An attempt has therefore been begun to study the elastic behaviour of specimens of such materials by means of elastic vibration, either of acoustical or supersonic frequency. Special means are, of course, required to set in vibration a short rod of weak brittle material which cannot be subjected to direct mechanical action. Preliminary experiments have been made with short rods of nickel, and no difficulty has been experienced in exciting longitudinal vibrations in these by means of the magneto-striction effect. This, however, is obviously not applicable to non-magnetic materials, and attempts to excite vibrations in these by electrical means have been begun. Considerable development of the method and apparatus will be necessary before elastic measurements can be made.

Some crystals of copper and of silver have been prepared in the course of research on fatigue of metals. Some experiments have been made on the preparation of single crystals of bismuth, in which the conditions were varied by using different steady temperatures in the furnace through which the tube in which the metal is crystallising is lowered, and by independently varying the rate of lowering. These led to interesting results, and it seems probable that variations in the nature and distribution of the impurities present in the metal have a predominating influence in determining the mode and character of crystallisation, as compared with other factors, when the rate of solidification of the metal is very small.

Surface Tension of Liquid Metals

Work on the surface tension of liquid metals has been directed mainly to tracing the source of errors which are indicated by the difficulty of obtaining reproducible values for the surface tensions measured under certain conditions. In the case of a number of low melting metals, when determinations were made on a rising temperature it was noticed that very erratic results were obtained until the temperature of the metal had risen to about 500° C. If the metal had been previously heated to 1000° C. and determinations were made on a falling temperature, results which could be readily reproduced were obtained down to a much lower temperature, for instance, in the case of tin down to about 300° C. This result may be due to alterations in the molecular association of the liquid metal or to the presence of a very fine film of oxide which may be removed at the higher temperature. It has also been noticed in the early work that while it was rather difficult to obtain good duplicate results for tin when not far removed from the melting point, for instance, at about 250° C., quite satisfactory duplicates could be obtained in the case of lead down to 350° C.

For the work on the effect of gases in steel, a refractory crucible or container for use with the induction furnace was required which would withstand conditions for which the china-alumina crucibles at present used in induction furnace practice are not suitable. Resistance to high temperatures, rapid heating, and severe temperature gradients, and the power to withstand the corrosive action of fluxes of a wide variety of acidic or basic composition under oxidising conditions, were required for this purpose. Crucibles and tubes made from specially treated chromite ores were found to be suitable and are now giving satisfactory service in this research. The work on the production of articles of pure

alumina of increased mechanical strength by suitable grinding, grading and acid treatment has been extended, and tubes, crucibles and other apparatus are now being produced in this material which are comparable in strength with that of well-fired articles of china clay. This hard material has proved of great value in several high temperature researches and in the development of new methods of pyrometric investigation.

Heat Treatment and Stresses

The internal stresses in heat-treated material arise from changes occurring during quenching. Slowly cooled material is free from such stresses. Attention is now being devoted to the question of the influence of modified forms of heat treatment, particularly in regard to the quenching operation itself. In one case the dimensional changes on the subsequent machining of "Y" alloy test-pieces were reduced by approximately 80 per cent. by a modification of the heat treatment.

The Brinell hardness of material heat-treated in this relatively large thickness is somewhat higher than that of sheet, or of 1 in. diameter bars of the same alloy, and also than that of slices 1 in. thick cut from the ends of the actual test pieces and re-heat-treated. This higher hardness is probably due to "tempering" or ageing, which takes place during the relatively slow cooling in the quenching medium. A 3 in. diameter billet, 5 in. long, quenched from 520° C. in boiling water, keeps the water boiling gently for over two minutes, and then violently for about half a minute, at the point where the spheroidal condition of the water ceases. During this time ageing may take place. Pieces of such thickness probably do not undergo further ageing at room temperature. The observed length remains very constant over a period of time after heat treatment. The measurements obtained in the course of this investigation are discussed in more detail in the report on the Metrology Department.

Much further attention has been given to the question of the removal of dissolved gases from aluminium alloys, by the presolidification process, by the passage of nitrogen, and by other means. While these processes have continued to give valuable results, both in the laboratory and in large scale industrial application, certain outstanding difficulties have made themselves felt, principally with regard to the regularity of the products. The conditions in which the nitrogen process can be most advantageously applied have been further studied, with the result that steady improvement has been obtained. Attention has also been given to the method devised by D. J. Tullis of using chlorine or a volatile chloride for the purpose of removing other dissolved gases from aluminium alloys. Some new developments of this process have been studied and highly interesting results obtained.

"Y" Alloy

The steadily extending use of "Y" alloy, originally developed in the Metallurgy Department of the Laboratory, has raised a number of important questions regarding the influence of impurities upon the alloy, and the possibility of replacing part of its nickel content with iron. These questions, which are of considerable practical importance and are also of interest in connection with the issue of standard specifications for this material, have necessitated a considerable amount of experimental work. In the course of this work it has been found that 1 per cent. of zinc appears to soften the alloy in hot-rolling. Tin causes cracking; the smallest amount added (0·01 per cent.) appears seriously detrimental in this respect. Zinc, on the other hand, up to 1 per cent., appears to have no undesirable effects on the tensile properties or hardness of the heat-treated rolled rod at room temperatures. With regard to the effect of iron, it has been found that alloys of modified composition in which part of the nickel has been replaced by iron, with or without a reduction in the manganese content, have excellent hot-working properties, and give, under normal heat treatment, tensile properties at room temperatures superior to those of "Y" alloy of normal composition. The question whether these modified types of "Y" alloy are as good as the normal type at higher temperatures yet remains to be investigated.

Failure of Chains

In continuation of the investigation on the causes of failure of wrought-iron chains, attention has been turned to a defective condition sometimes encountered in wrought iron, in which the iron is commonly described as "burnt." In this condition the ductility and the impact strength of the iron are very considerably reduced, and the fracture has a characteristic coarsely crystalline appearance. It has been shown that this defect is not a consequence of burning in the sense of oxidation or overheating, but is actually due to the presence of excessive proportions of phosphorus and silicon in the iron.

At the request of the Home Office, the research on chains and hooks has been extended to include the investigation of the causes of failure of steel chains and steel fittings attached to wrought iron chains. As a preliminary step, a questionnaire was drawn up by the investigators and circulated by the Home Office to makers, users and repairers of these chains and fittings. From the replies to the questionnaire, valuable information has been obtained relating to the incidence of failure and the present practice as regards periodical heat treatment. Samples of chains and fittings which have failed in service, as well as unbroken chains and fittings of known history as regards service and heat treatment, have been offered for examination and testing.

In view of the importance which the Home Office attaches to the work on steel fittings, it has been decided to give priority to this section, and to hold in abeyance certain tests which were previously contemplated on the effect of low temperatures on used iron chains.

Alloys of Nickel and Chromium

It has been proved that the alloys of nickel and chromium do not form a homogeneous series of solid solutions, as was advanced in the equilibrium diagram published by Voss. It appeared unlikely, in view of the widely different atomic arrangements of the two constituent metals, nickel and chromium, that such a series of solid solutions should exist. The experimental data obtained now serve to show the existence of a eutectic at the minimum of the liquidus curve. This eutectic is formed of two markedly distinct phases, consisting of the saturated solid solutions of the two metals in each other. The solidus temperatures of the nickel-chromium and the nickel-chromium-iron alloys have now been determined, and considerable progress has also been made with the determination of the constitution of these binary and ternary alloys systems in the solid state.

The work which has been done in the production and study of the properties of the nickel-chromium alloy derivatives has yielded much information, which appears to be of value in its application to the practical utilisation of materials, at high temperatures. The prolonged stress tests, as well as the usual short-time tensile tests, for example, have indicated that many of the alloys appear to be more resistant at high temperatures when used in the cast condition than after they have been rolled or forged. This is of some importance, since it would serve to justify the use of a group of alloys having very high resistance to prolonged loading at high temperatures, which, however, cannot be forged or rolled. An important point is that alloys having very high strength at high temperatures are necessarily also very hard and strong at room temperatures, and therefore become difficult in regard to machining. Fortunately the modern development of extra hard cutting tools of the tungsten carbide type makes it possible to overcome this difficulty, so that even the hardest of the alloys of the group investigated can be fairly readily machined.

Alloys of Iron

The research on the alloys of iron has been continued under the auspices of the Alloys of Iron Research Committee. The investigations on the alloys of iron, silicon, chromium, and manganese have also been continued, but the work meets with formidable experimental difficulties. As pointed out in last year's report, the problems associated with maintaining the metals and alloys in a state of adequate purity have been to a very large extent solved, and in all the series under investigation alloys of satisfactory composition have been prepared. A further, and if possible still more formidable, series of experimental obstacles has then been encountered in connection with the measurement of temperatures, such as those of liquidus, solidus, etc., in these systems. This difficulty is associated in part with the very high temperatures at which these alloys melt and solidify, and in part with the fact that contamination of the thermocouples ordinarily employed for work of this kind tends to become serious under these conditions. A large amount of work has accordingly been necessary in order to secure an adequate accuracy of temperature measurement for the determination of the equilibrium diagrams.

Metallurgical Topics: Monthly Notes and Comments

From Our Own Correspondents

Electrochemistry in America

THERE is no scientific institution in this country quite like the American Electrochemical Society, which held its fifty-seventh general meeting in St. Louis during the last three days of May. It combines all the branches of applied science involving electro-chemical considerations, whereas in Great Britain these are shared by three, at least, and only one of them is highly specialised—electroplating and electrodeposition. The Institution of Mining and Metallurgy deals occasionally with the electrolytic extraction of metals, and the Faraday Society devotes itself from time to time to the reading and discussion of papers of a high order of interest in the chemico-physical aspects of some of the subjects which involve electro-chemical laws and principles. Yet, from the point of view of Empire development, the science and art of the electrolytic extraction of metals is of vast importance, particularly in countries like Canada and Australia, where water power, and therefore cheap electrical energy, is available. For the purpose, too, of producing base and other metals of a high degree of purity, for which there is an ever-increasing demand, the electrolytic extraction of metals is becoming more and more important. At the recent meeting of the American Electrochemical Society there were no fewer than eight papers dealing with various aspects of the subject. One of these was a paper of a general character designed as the introduction to a symposium on Hydro-electrometallurgy, and was entitled "Status of Electrolysis as a Metallurgical Process." It was by T. H. Donahue, of the Anaconda Lead Products Co., East Chicago.

A Symposium on Hydro-electrometallurgy

THIS paper shows that electrolysis is now a recognised industrial alternative to other extractional processes for the production of copper, zinc, gold, nickel and cadmium, and the predominant process for producing copper, silver and bismuth from crude metal, and cadmium from precipitates. On the other hand, the author makes the interesting observation that in spite of the growing recognition of the value of high purity metals, no permanent premium can be expected for more than a limited amount of each, and that success depends on being able to produce them more cheaply by electrolysis than by other processes. The paper gives data as to the relative quantities of each of the leading metals produced electrolytically, and by the older methods of smelting and furnace refining, and points out some of the limitations of electrolytic refining. The production of tin, antimony and other metals is touched on briefly. Aluminium is, of course, produced wholly by an electrolytic process, and the same may be said of magnesium (not mentioned in the paper), but these, of course, did not come within the scope of the symposium, which dealt with hydrometallurgy, and not with the electrolytic refining of molten metals, nor with their production by such means. In the symposium itself there were papers dealing specifically with copper, lead and zinc electrolysis; the preparation of pure electrolytic nickel, and two short but none the less interesting papers on the recovery of indium, and on the production of germanium, in the process of zinc production. In regard to some of the metals referred to above, there were in two or three cases more than one paper.

The Hydrometallurgy of Copper

THUS the production of copper was the subject of two: one by C. T. Barsch on "Hydrometallurgy of Copper at the Bagdad Property" (Arizona), and one by F. R. Corwin and C. S. Harloff, on "The Series System of Electrolytic Copper Refining at Nicholls Copper Co." The ore minerals treated at the first-named works are chalcopyrites and chalcocites containing from 1 to 1·25 per cent. of copper, which after roasting are leached with spent sulphate electrolyte and brought up to a concentration of 60 grammes per litre, but with free sulphuric acid falling too low for good extraction. An electrolyte of 50 grammes copper and 25 grammes acid per litre is eventually obtained, and the current density employed is 20 amps. per sq. ft. The cell voltage has ranged as low as from 1·95 to 2·12 volts. Extractions as high as 97 per cent. copper from the calcine are attained, and good roasting is essential, but in practice they average 89 to 91 per cent. The second paper, by Corwin and Harloff, describes the economies effected by the series system, which is cheaper than the multiple system, as less space is required, less power, fewer tanks and less capital expenditure in conductors and bus bars. Relatively high impurity electrolytes can be used and yet the production quality remain high. Finally, the precious metal loss to the cathode deposit has been controlled in the series system, so that it compares favourably in this respect likewise with the multiple system.

Electrolytic Lead and Zinc

THE paper on electrolytic lead refining is by J. J. Fingland, and describes the Betts process, as carried out at the celebrated Trail plant, British Columbia. The author regards the descriptions given in current literature and text books as meagre and out of date, and failing to give due importance to the Betts process, which compares with the best methods for the electrolytic production of copper. The cells, which are arranged in multiple and cascade, are made of concrete, lined with asphaltum, while for the circulation of the electrolyte, plunger and centrifugal pumps constructed of copper, with monel metal wearing parts are employed. The paper gives full details as to the equipment required and the mode of operation practised, and discriminates between the methods by which common lead is made, electrolytically, from impure lead bullion, and the care and precautions which have to be observed in making the highest grades of refined lead, when the impurities in the anode bullion must be controlled within narrow limits. The influence of silver in the cathodes and of copper in the anodes is described. The former must be kept low, while the presence of the latter, in excess of 0·04 per cent., forms a hard skin on the surface of the anode, insoluble in hydrofluoric acid. The recovery of the gold and silver from the anode sponge presents no unusual features, and about 80 per cent. of the bismuth contained in the bullion is found concentrated in the copper oxide slag recovered just prior to the finishing of the doré charge. The paper read at the meeting, dealing with zinc extraction, included two embodying the latest practice, one of which, by U. C. Tainton and E. T. Clayton, contain a particularly interesting research on "Germanium in relation to Electrolytic Zinc Production."

Effect of Impurities on Metal Deposits

THIS is quite a short paper but, for many reasons, it may be regarded as perhaps the most important of all those read at the meeting, for it embodies in the very highest degree the scientific spirit that prompts research and leads to discovery, and at the same time has directly practical applications. In the electrolysis of zinc, conditions may arise when the hydrogen overvoltage falls below that necessary for the separation of zinc. These include temperature, current density and the presence of certain impurities which may be deposited with the zinc and lower the over voltage below the critical point. In the circumstances that led to the research in question certain high-grade and relatively clean concentrates from the Toplin district were required to be treated electrolytically, and a pilot plant was operated for that purpose. Many anomalies revealed themselves; sometimes the zinc deposits showed a great tendency to re-dissolve; occasionally no zinc at all would be produced. Control of the variables and the examination of the electrolytic circuit failed to reveal the cause, which had not been ascertained by the time the industrial plant itself had been set in operation, when the same troubles occurred, of course on a larger scale. It was surmised that some unexpected element with an extremely detrimental effect upon the hydrogen overvoltage was present which prevented the production of good zinc, but analysis failed to reveal the particular impurity present.

The Scientific Spirit of Research

INTENSIVE research work was thereupon carried out in test cells, by adding various elements which, owing to their position in the periodic table, might be suspected of causing the trouble, and in the course of the investigation it was found that the presence of various rare elements spoil zinc deposits, even when occurring in very small amounts only. Each

element appears to give rise to a particular sort of deposit, and it is possible to recognise the nature of the element causing the trouble, from the character of the corrosion of a corroded zinc cathode. Apart from the value of the information thus gained, it was found that when germanium was added, results similar to those encountered in the pilot plant, and later in the commercial plant, were encountered. The inference, apart from purely analytical considerations, was drawn, in accordance with truly scientific inductions, that it was germanium which was occasioning the troubles, and that as little as one milligramme per litre—hardly determinable by analysis, could cause those results. That inference was acted upon by the treating of a solution containing a known amount of germanium in various ways, whereupon it was found that the addition of ferric hydrate neutralised the effect. The mechanism was further found to be the addition of sufficient iron, per litre of solution, to ensure the precipitation of any germanium likely to be present; this practice led to normal deposits being produced. In the paper it is noted that Hausen, experiencing trouble with zinc electrolytes, had ascribed it to the presence of vanadium, an element which, when added in the present case, gave no objectionable results. Emphasis is laid on how little is actually known on the subject of the effect of impurities on zinc electrolysis, but it may be said that the admirable work of Tainton and Clayton, as embodied in the paper, has already helped to add very considerably to the knowledge already possessed.

Non-Ferrous Metals Research

A HIGHLY satisfactory report was presented at the annua meeting of the British Non-Ferrous Metals Research Associa-l tion, held in Birmingham, on Tuesday, with Mr. Thomas Bolton in the chair. During the past year, it is stated, the support of the association by the industry had increased from £9,167 to £11,434, a greater advance than in any previous year. Every effort was to be made to increase the maintenance contributions from the industry to the full £16,000, which would assure the maximum Government grant of an additional £8,000 a year. The research results during the year had also exceeded in importance and volume any previous record, despite a slight curtailment of the research programme. Further, great strides had been made in development work. With regard to the establishment of headquarters for the association in London, it was stated that the amount required was estimated at £30,000. The urgency of this question could scarcely be over-stressed.

Referring to the progress of the association during the past ten years, the report added that they now possessed the nucleus of a really strong organisation much more competent to-day to afford service than ever before. They realised that even investigations which in the early days appeared too abstract or "fundamental" did, in time, promise a harvest of new knowledge which could be applied to immediate industrial objectives.

Dr. H. W. Brownsdon, a vice-chairman of the Association, speaking on its work, considered the future was rosy. They had gained a great deal of experience, and what they had to do now was to put that experience into practice.

Science and Industry

"THE keenest competition from abroad," runs a passage in the report, "comes from those countries where very active scientific and industrial research on metals is in progress. Within the last few years large provision has been made in Germany and the United States of America for co-operative and industrial research, the expansion of which is taking place at a prodigious rate. The question, therefore, deserves stressing as to whether we in this country are doing anything like enough to maintain our competitive power in so far as it can undoubtedly be assisted by the application of science to industry."

This point was further stressed in a speech at the luncheon by Dr. F. E. Smith, secretary of the Department of Scientific and Industrial Research, with which the Non-Ferrous Metals Research Association maintains close and happy relations. Occasionally, he said, they had accidental discovery, but the bulk of discovery was due to the intense pursuit of knowledge on the part of groups of people or an individual. If they took industries in general, they would find that those industries that were founded on a scientific basis and had walked hand in hand with science never suffered when there was a general depression in the country.

Beryllium in Canada

As a result of the numerous inquiries that have been received, following the publicity recently given to the occurrence of beryl in Canada, the Mines Branch of the Dominion Department of Mines has issued a statement on the subject.

Many of the recorded occurrences of beryl in Canada have been found as a result of mining operations for mica or felspar, beryl being a not infrequent mineral in certain of the pegmatite dykes that have been worked for these products in Ontario and Quebec, and also in British Columbia. In another instance beryl has been found in a pegmatite explored for molybdenite. In none of such workings, however, is beryl known to have been found in commercial quantity.

A single deposit of possible economic interest is known in Ontario, and was worked on a small scale in 1926, with the production of a few tons of small, green beryl crystals, which were shipped to Germany. The beryllium oxide content of this beryl was 14·38 per cent. The mineral occurs as small crystals, averaging about 3 in. across, scattered rather thickly through a narrow, 10 ft. pegmatite dyke, which is exposed for about 150 ft. Some of the larger crystals yield small, clear fragments approaching gem quality (aquamarine), but most of the material is cloudy, stained and flawed.

No Important Tonnages

THE discovery of beryl in south-eastern Manitoba, in the Winnipeg River-Bird River region, which district has latterly been actively prospected for lithium minerals and tin, has received a good deal of publicity. There is an extensive development of pegmatite dykes in the region, many of which carry lithium minerals and some of which carry tin. In certain of the dykes small amounts of beryl have been noted, either in the form of scattered individual crystals or crystal aggregates, but nothing is yet known to have been found that would justify the belief that important tonnages exist. The crystals are pale green or, more rarely, colourless, and are of small to medium size, measuring up to 24 in. long and 10 in. across. Analysis of a sample from the Silver Leaf lithium mine, just south of the Winnipeg River, showed a content of 12·74 beryllium oxide. No attempt has yet been made in the district at beryl production, though it is reported that several small sample shipments have been made of crystals found during prospecting operations for tin or lithium minerals. While the existence of commercial quantities of beryl in this region is always a possibility, observations of Geological Survey and Mines Branch officers who have examined the occurrences indicate that insufficient beryl has as yet been found to warrant the belief that the discoveries can be worked for their beryl content alone,.

Copper Welding

FURTHER information on the subject of copper welding is contained in a leaflet recently issued by the British Oxygen Co., Ltd., Angel Road, London, and based on several months' research and investigation by their technical staff. Joints in copper effected by welding are far superior to those obtained by any other method and are equal in strength to the original metal, with all the characteristic properties of the metal. Owing to the great conductivity of copper, however, and the consequent rapid dispersion of heat, welding is more difficult and cannot be done with the same economy as in the case of iron and steel. Other difficulties arise from brittleness caused by the effects of the oxides on cooling and the absorption of gases such as hydrogen, oxygen and carbon monoxide, all of which may be present in the oxy-acetylene flame. As the metal solidifies after welding, these occluded gases are given off, leaving the metal a mass of blowholes.

For successful welding, therefore, it is necessary to provide something which will counteract both these detrimental effects. This is done by the use of suitable deoxidisers, which are incorporated in the welding rod; pure copper being entirely unsuitable for use as a welding rod. These deoxidisers tend to prevent absorption of gases by the metal during welding, also reducing the oxide as it is formed. A suitable flux, consisting of a combination of borates, must also be employed in order to clean the metal chemically of superficial impurities. This flux should not be used in large quantities, and is best applied by dipping the end of the heated rod into the flux.

Trade, Commerce, Finance: The Month in Review

From Our Market Correspondent

THE depression in the iron and steel trade has not lifted during the month that has just passed; indeed, it is no exaggeration to say that it is becoming gradually more pronounced, and the immediate outlook is gloomy. It is the considered opinion of those who are in a position to judge that we are faced with one of the worst years in the experience of the steel trade. It is no local or seasonal disturbance. The trouble is deep seated and widespread, and one can see no way out at present. There is an entire lack of confidence, but instead a feeling of apprehension. A glance at the Stock Exchange list of prices of industrial shares shows the panicky state of mind of the general public. Money is not being spent freely, buying is restricted to the absolute minimum, and orders are held back to the last moment. That is the situation in this country, and reports from the Continent and America reveal a similar state of affairs.

Conditions in Other Countries

In Germany the high level of unemployment, the number being well over two millions, shows how unsatisfactory business conditions are there. Iron and steel production in that country is steadily declining. The same kind of report comes from Belgium. France is still enjoying a fairly good home demand for steel, but the export trade is very bad, and the depression is likely soon to spread to the home market. The returns from America show a noticeable decline in the steel industry, the production in April being 81 per cent. of capacity as compared with 97 per cent. in April last year. The slump is evidently world-wide, and as such it is of very serious import to Great Britain in her unique position. Our home market, which is free to all comers, is bound to attract attention from the foreign steel-producing countries, who are having to look abroad for orders to make up the deficiency in their home trade, and we are likely to experience very shortly an intensity of foreign competition which will severely test the British steel works. It is reported that the European Cartel has practically completed its negotiations with the British merchants, and unless some unforeseen hitch occurs we shall soon see a considerable increase in the inflow of Continental steel. This invasion of our market, along with the reduction in our home demand, will magnify the difficulty of keeping steel-works in anything like satisfactory operation. This adverse movement can be deemed a certainty, while the prospect of opening out any source of improvement is just as uncertain, so that taking all things into consideration we seem to be in for a very bad time. The Whitsuntide holidays are upon us, they will add to the dislocation of trade, more so than usual, as the stoppage will undoubtedly be prolonged on account of the shortage of work. We shall then be faced with the usual slack summer season, and the year looks like dragging on in unrelieved depression. It is a doleful picture, but it represents the general opinion of those connected with the trade.

Attitude of the Government

It will be interesting to see what steps, if any, the Government will take to deal with the situation. The steel makers themselves have done and are still doing their utmost to cope with their own difficulties. They have reduced prices to a greater extent than any other section of industry, as far as possible the works are being kept in an up-to-date condition, amalgamation and rationalisation schemes are being carried through in response to the demand from high quarters; yet they are faced with diminishing order books which will cause the reduction of output below the already uneconomic level. The only help received from the Government so far is the derating relief, but that is a mere palliative and does not touch the root of the trouble; and against that we have to put the increase in the cost of social service and taxation, and the serious dislocation which resulted from the uncertainty about the McKenna duties. The insistence upon the necessity of safeguarding for the steel trade is daily becoming stronger. It is perhaps a misfortune that the Conservative party have adopted safeguarding as their policy, as the present Government, by the law of party politics, are bound to oppose it, and it may be a long time before the Conservatives have another opportunity of putting it into effect. It is just possible that the pressure from inside its own ranks will force the Labour Government to give way, particularly if the rise in the unemployment figures continues unchecked. The pity is that while the urgent needs of the industry are being subordinated to party politics, ground is being lost which it will be very difficult, if ever possible, to recover, and for many firms the present year may bring irretrievable disaster.

New Steel Works

It is doubtful whether the general position will be improved by the projects for the building of new steel works, which have been announced in the Press. The amalgamation of the Lancashire steel works under the title of the Lancashire Steel Corporation, which is being carried out under the auspices of the Bankers Industrial Development Company, has aroused much interest, and appears to be regarded as a very desirable scheme. But is it? The scheme includes the provision of entirely new plant, which in due time will enter the already overcrowded market, with resources which will enable the Corporation to compete in a manner that will be detrimental to the whole industry. What we need is a reduction in the number of steel works, not an increase, and if we could have the closing down, without replacement, of some of the plants which have shown themselves incapable of carrying on, the better it would be for the steel trade. We have had a few instances of amalgamations in the name of rationalisation, and if the truth were told it would be found that their main achievement is the cutting of prices to a level which spoils the business for themselves and for everyone else. They really have no choice. "Output, Output" is the cry, and how can output be secured with the present excess of productive capacity other than by under-quoting? That is the trouble with these new, up-to-date plants. They have to be built for large outputs in order to attain the promised low production costs; they fail to get sufficient work to give the required economic output, as their competition is met by other steel works, equally desperate in their attempts to secure orders, and so they fail in both purposes. However, it will be a year or two before these new works can be brought to completion, and in that time much may have happened to alter the whole situation.

Iron and Steel Prices

In view of what has been said, it cannot be expected that there will be any cheerful reports from the various sections of the iron and steel market. There is no change in the price of foundry pig iron, but sales are very limited, and makers are thankful for orders of any kind, however small. It was generally expected that there would be a reduction in the prices for the Midlands, but the Central Pig Iron Producers' Association at their meeting last week decided to make no alteration. They have no doubt taken the sensible view that a reduction would not bring out any more business, and that they might as well maintain the price for what orders are available. There has been a sharp fall in the price of hematite pig iron, varying from 2s. to 3s. per ton, the object being to induce buying so that the present output can be maintained. The response so far has not been encouraging. The official prices of steel plates and sections are unchanged. The associated steel makers realise fully that nothing will be gained by reducing prices, and they are not likely to be frightened into a false move. The prices of uncontrolled materials continue to show weakness. There seems to be no stable price for small bars or for boiler plates. The price at which orders can be placed depends on the degree of madness of some of the steel makers in their efforts to wrest business from competitors. The necessity for the complete control of steel prices, from the semi-finished billets down to the smallest sizes of bars and sections and all thickness of plates and sheets is more urgent than ever, but there is not yet sufficient unity among the steel makers to achieve this desirable object.

The production figures for April show a marked decline, which is partly accounted for by the Easter holidays. The output of pig iron was 619,600 tons compared with 665,800 tons in March, there being a reduction of six in the number of furnaces at work. The output of steel was 696,100 tons compared with 826,100 tons in March.

Some Inventions of the Month

By Our Patents Correspondent

Abstracts of other Patents of metallurgical interest will be found in our Patent Literature, published weekly in THE CHEMICAL AGE.

Casting Magnesium

To prevent oxidation of magnesium during casting is the object of an invention described in the Specification 326,820, dated December 19, 1928, of a Patent of Addition to Specifications 187,943 and 219,753, by I.G. Farbenindustrie Akt.-Ges. of Frankfort-on-Main, Germany, and A. L. Mond, of London. For this purpose, there is added to the moulding sand a non-hygroscopic fluoride or a fluoride which has been rendered stable in presence of heat and moisture by admixture with another substance. Suitable additions are, for example, 3 to 5 per cent. of ammonium hydrogen fluoride or ammonium silico fluoride, the mixture in the latter case being stored for some time before use, or a mixture of 5 per cent. of ammonium fluoride and 3 per cent. of oxalic acid to absorb any decomposition products. Such material, on contacting with the molten metal, produces a layer of non-oxidizing gas which protects the casting as described in Specification 254,302 (See THE CHEMICAL AGE, Vol. XV, p. 31 [Metallurgical Section]).

Chromium Plating

THE formation of chrome mists in a chromium plating bath is prevented by the provision of a protecting layer of a natural or artificial hydrocarbon or a hydrogenated hydrocarbon or a mixture thereof, the use of a hydrogenated hydrocarbon of high boiling point being preferred. See Specification 327,293 dated April 8, 1929, by R. Blasberg of Solingen, Germany.

Forming Metal Articles

A PROCESS of forming articles of not less than 0·05 mm. thickness consisting of or containing alloys free from tungsten and zirconium is described in Specification 326,518 (Johnson), dated September 15, 1928, a communication from I.G. Farbenindustrie Akt.-Ges. of Frankfort-on-Main, Germany. An article of the desired shape is first formed of one or more of the metals of the desired alloy, and the remaining constituents are thereafter caused to diffuse into the article. Such a process is particularly advantageous for the production of thin articles which cannot satisfactorily be cast. The diffusion may be complete or only to a certain depth, and may be effected, for example, by heating the article in metal powder, and, if desired, continuing the heating after removal of the powder, or by electrolytic deposition with subsequent heating. Specified metals are nickel, cobalt, iron, copper, chromium, aluminium, magnesium, manganese, molybdenum, and silver. Alloys containing silicon may also be made. In examples, (1) iron is embedded in cobalt, heated in hydrogen, and further heated after removal; (2) nickel is electroplated with chromium and heated; (3) iron is electroplated successively with nickel, chromium, and iron, and heated; (4) iron is heated at 300–400° C. in hydrogen containing silicon tetrachloride, and the deposited silicon is caused to diffuse into the iron by further heating in hydrogen at 900° C.

Smelting Ores

A PROCESS for smelting iron and other ores, particularly sulphide ores, in which are obtained separate layers of metal, matte, and a slag containing less than 15 per cent. of iron oxide, is described in Specification 324,902, dated August 3, 1928, by H. Skappel, of Oslo, Norway. The amount of matte that will be formed is calculated from the known composition of the ore, and there is added a sulphide having a heat of formation of at least 40 kilogram-calories per gram-atom of sulphur, *e.g.*, sulphides of aluminium, zinc, manganese, magnesium, or alkali or alkaline earth metals are suitable, as are also mixtures of sulphates and carbon which will produce such sulphides; the amount added must be sufficient to raise the mean heat of formation of the matte above 25 kilogram-calories per gram-atom of sulphur. The charge is then smelted with the usual additions. The following applications of the process are specified. (1) Iron ores containing manganese are smelted with addition of manganese sulphide to obtain a crude pig iron low in manganese, a matte containing about 50 per cent. each of iron and manganese sulphides, and a slag containing about 7 per cent. of iron oxide and sulphide and containing most of the phosphorus. (2) Elements such as arsenic, antimony, nickel, cobalt, molybdenum, and platinum present in iron ores are taken up in an iron speiss by addition of further ferriferous material. (3) Zinc-containing ores of lead, silver, and copper are smelted in an electric furnace at below 1,250° C. to collect the zinc as sulphide in the matte, or they are smelted in a blast furnace to slag and matte only with an addition of sodium sulphide or sodium sulphate and carbon, whereupon the matte is treated with molten iron or speiss to precipitate the lead and obtain separate layers of metal, matte, and slag. (4) A lead sulphide ore containing small amounts of other metals is smelted with calculated amounts of scrap iron, sodium sulphate, coke, and limestone to obtain separate layers of lead, a matte comprising iron and other sulphides, and a slag containing 3 per cent. of iron oxide. (5) Oxide ores, *e.g.*, of iron, chromium, or manganese, are treated with sulphides of calcium, magnesium, or aluminium, and by regulating successive additions of sulphide the metals are separated successively. (6) Ores of light metals, *e.g.*, alkali or alkaline earth metals, are treated in presence of a sufficiency of heavy metal sulphide.

Commercial Intelligence

The following are taken from printed reports, but we cannot be responsible for any errors that may occur.

Mortgages and Charges

*[NOTE.—The Companies Consolidation Act of 1908 provides that every Mortgage or Charge, as described therein, shall be registered within 21 days after its creation, otherwise it shall be void against the liquidator and any creditor. The Act also provides that every Company shall, in making its Annual Summary, specify the total amount of debts due from the Company in respect of all Mortgages or Charges. The following Mortgages and Charges have been so registered. In each case, the total debt, as specified in the last available Annual Summary, is also given—marked with an *—followed by the date of the Summary, but such total may have been reduced.]*

BARROW HÆMATITE STEEL CO., LTD. Registered April 23, supplemental trust deed dated April 14, 1930, securing unpaid instalments of interest in respect of first debenture stock and interest on said instalments, etc.; charged on properties charged by trust deeds dated June 10, 1919, etc., also general charge. *£1,190,706. April 9, 1930.

DORMAN LONG AND CO., LTD., Middlesbrough, steel manufacturers. Registered May 10, £1,624,073 debenture stock, part of amount already registered; charged on property charged by trust deed dated July 26, 1923. *£5,846,273. December 31, 1929.

FEDERATION TIN MINES, LTD., London, E.C. Registered March 14, £7,500 debentures; charged on certain mining leases, etc., in Tasmania; also general charge. *£22,500. March 12, 1929.

GALLOIS LEAD AND ZINC MINES, LTD., London, E.C Registered May 2, £6,100 debentures, part of £20,000; general charge (excluding plant, etc., where purchase price is not fully paid).

LAGARES TIN MINES, LTD., London, E.C. Registered April 11, series of £16,000 prior lien debentures, present issue £11,000, charged on certain shares, etc., also general charge (ranking in priority to first debentures). *Nil. April 3, 1929.

TINDALE ZINC EXTRACTION, LTD., Newcastle-on-Tyne. Registered April 25, £3,000 first debenture, to Branch Nominees, Ltd., 15, Bishopsgate, E.C.; charged on land at Midgeholme and Farlam, also general charge; also registered April 25, £4,000 debenture, to Sir R. A. Pease, 92, Northgate, Darlington, and others; general charge (subject, etc.). *Nil. January 10, 1930.

Satisfactions

ALUMINIUM CORPORATION, LTD., London, S.W. Satisfactions registered April 30, £1,100, registered April 22, 1918, £1,250, registered January 25, 1919, and £3,000, registered November 28, 1921, registered May 3, £1,028, part of amount registered March 22, 1920, and £100, part of amount registered August 22, 1921.

BWANA M'KUBWA COPPER MINING CO., LTD., London, E.C. Satisfaction registered May 6, £300, part of amount registered April 13, 1928.

CHEMICAL PLANT

for ALL PROCESSES

autoclaves · condensers
dephlegmators · driers
evaporators · mixers
stills · tanks · vessels
of all kinds

We are the actual manufacturers of plant to our own designs or Engineers' Specification. Catalogues on request.

COMPLETE INSTALLATIONS FOR CHEMICAL WORKS, OIL REFINERIES, FOOD MANUFACTURE, DRUGS, DYES, ACIDS, ESSENTIAL OILS, etc., etc.

W. J. FRASER & CO., LTD., DAGENHAM, ESSEX

FRASERS of DAGENHAM

TAS/Fz. 98

TIME
DOES NOT
WAIT FOR
YOU

YOU NEED NOT
WAIT FOR DELIVERIES
OF

SOLVENTS
AND
PLASTICIZERS
TO
STANDARD
SPECIFICATION

TRICRESYL PHOSPHATE
TRIPHENYL PHOSPHATE
DIBUTYL PHTHALATE
BUTYL LACTATE

AMYL ACETATE
BUTYL ACETATE
ETHYL ACETATE

CHEMICAL
SUPPLY CO. LTD.
OFFICES: 7 IDOL LANE
LONDON, E.C.3
WORKS: ABBEY ROAD
BARKING

INDEX TO ADVERTISERS

Accurate Recording Instrument Co., Ltd. xxviii
Adamson (D.) & Co., Ltd. .....xii, June 14
Aldred, Shirley & Co., Ltd. .....xvi, June 21
Aluminium Plant & Vessel Co., Ld. xi, June 21
Appleton & Howard, Ltd. .....xvi, June 7
Armco International Corporation
Front Cover, June 21
Ashdown (H. E.) (B'ham), Ltd. ..xx, June 7
Averill (C. R.), Ltd. (Sole Agents for Jos. Dixon Crucible Co.).....xii, June 7

Bagshawe & Co., Ltd.....xiv
Baillière, Tindall & Cox .....xxxviii, May 24
Baker, Perkins, Ltd.....v, Mar. 8
Bamag, Meguin (G.B.), Ltd.....xii, June 14
Barclays Bank, Ltd.....xvii, June 21
Barter Trading Corporation, Ltd.xvii, May 24
Bausch & Lomb Optical Co., Ltd...v, April 26
Beaumont's, Ltd.....xxvi, May 31
Belgian State Railway.....xviii, June 21
Bell Bros. (Manchester) Ltd.....xxix, May 31
Bellingham & Stanley, Ltd.....xxvi, May 24
Benn Brothers, Ltd.....xii, Nov. 16
Benn (Ernest), Ltd. .....vi, June 14
Bennett & Jenner, Ltd. xxx
Best (Jas.) & Sons.....xvii, June 21
Blagden (Victor) & Co. .....589, June 21
Boots Pure Drug Co., Ltd. .....ix, June 7
Braby, F., & Co., Ltd. .....*Cover* ii, June 7
Breaks Bros.....xxxvi
Bright (John) & Bros., Ltd. ....xxiii, June 14
British Carbo Union, Ltd. 621
British Commercial Gas Association.....xiii
British Drug Houses.....xxx
British Industrial Solvents, Ltd.
Front Cover, May 24
British Resistor Co.....*Cover* iii, June 14
British Steam Specialties, Ltd.....vii
Broadbent (Thos.) & Sons, Ltd. xxx
Broom & Wade, Ltd. 617
Brothers Chemical Co. (1922), Ltd.....x xxi
Brotherton & Co., Ltd. xxix
Brough (E. A.) & Co. .....xxi, June 7
Brown & Son (Alembic Works), Ltd. xxxii
Burckhardt Engineering Works vii
Burdin & Co. (1928), Ltd. .....xvii, June 21

Cafferata & Co., Ltd.....xvi, June 21
Calorizing Corpn. of Gt. Britain, Ltd. xxxiv
Cape Asbestos Co., Ltd. .....vi, June 21
Carlson (John).....xvii
Carter (J. Harrison), Ltd. v
Carty & Son, Ltd.....xiv
Chance Bros., Ltd. .....ii, June 7
Chemical Supply Co., Ltd.....ii
Chemicals & Coke Ovens, Ltd. *Cover* iv, June 7
Chesterfield Tube Co., Ltd.....xvi
Christy & Norris, Ltd. viii
Churchill (J. & A.).....viii, May 24
City of Manchester Education Committee
ix, June 21
Clayton Rubber Co., Ltd.....vii, June 21
Clifford (Chas.) & Sons, Ltd. .....xxi, June 7
Collett (J. M.) & Co., Ltd.....xxxiv
Commercial Solvents Corporation.....xix
Cook (Chas. W.) & Sons.....iv, June 21
Cortin & Corking, Ltd. xxxvi
Crane (Fredk.) Chem. Co. .....xviii, June 21
Crone & Taylor, Ltd.....xii, June 7
Crosby, Lockwood & Son .....xxiii, May 24
Cuthbertson (Jas.) & Co., Ltd. .....vi, June 7

Dale (John) Mfg. Co. iii
Dexine, Ltd.....*Cover* iv, June 21
Dickinson (Arthur J.), Ltd. ..*Cover* iii, June 21
Dorr Co., Ltd. vii
Durastic Bituminous Paint Co. .....vi, June 7

Emco Dyes, Ltd.....xvi, June 14
Empress Coppersmiths & Engineers, Ltd.
Cover ii, June 14
English China Clays, Ltd. .....xviii, June 21
Evans, Adlard & Co., Ltd. .....ix, June 7
Evans (R. H.) & Co. .....xvi, June 14

Feltham (W. H.) & Son iii
Fiechter (Emil).....xx, June 7
Firth (Thos.) & Sons, Ltd. .....viii, June 21
Foamite Firefoam, Ltd. .....549 June 7
Follows & Bate, Ltd. .....ix, June 21
Ford (T. B.), Ltd. .....*Front Cover*, June 7
Foster Instrument Co. .....xiv, June 7
Four Oaks Spraying Machine Co., Ld. v, May 24
Foyle (W. & G.) .....xxviii, May 31
Fraser (W. J.) & Co., Ltd. i

Gardner (Wm.) & Sons .....iii, June 21
Gas Light & Coke Co.....xii
General Chemical and Pharmaceutical Co., Ltd. (The) .....v, June 14
Glover Bros. (Leeds), Ltd. xxiv
Graesser-Monsanto Chem. Works, Ltd. xviii
Greeff (R. W.) & Co., Ltd. xxvii
Griffiths Bros. & Co. (London), Ltd. viii, June 21
Guthrie & Co. .....*Cover* ii, May 10

Haller & Phillips, Ltd. xxxvi
Harris, J. W. xxxii
Harris (I. L. & G. S.), Ltd. .....*Cover* iii
Haughton's Patent Metallic Packing Co., Ltd. xxxiii
Hickson (E.) xxxii
Hill-Jones (Thos.), Ltd. xxxiv
His Majesty's Stationery Office ..xxx, May 24
Holland (Bernard) & Co. .....viii, June 7
Honeywill Bros., Ltd. xxiii
Honeywill (C. & W. R.).....xxiii, June 14
Hopkin & Williams, Ltd. xxxii
Horne Engineering Co. xxxv
Howards & Sons, Ltd.....61
Hughes (W. C.) & Co. .....xxx, April 26
Hurrell (G. C.) & Co. iv
Hyde (Silas) .....xviii, May 31

I.G. Dyestuffs, Ltd. .....xv, June 14
Imperial Chemical Industries, Ltd. xxvi
Insoles, Ltd.....xxi
Institute of Chemistry .....xiii, June 14

Jahn (F.) & Co. .....xxv, May 24
Jenkins Bros., Ltd. .....xvii, June 14
Jenkins (R.) & Co., Ltd. .....ii, June 21
Johnson (C. H.) & Sons, Ltd. .....xx, May 24
Johnson (D.) & Son, Ltd. .....xvi, April 19
Johnson, Matthey & Co., Ltd. viii

FOR CLASSIFIED INDEX TO TRADES SEE PAGES xxx & xxxi

COTTON
LINERS
for
Casks, Sacks and Barrels
for the
CHEMICAL INDUSTRY
also
Cotton Bags

W. H. FELTHAM & SON
Imperial Works
Tower Bridge Road
London, S.E.1
WORKS:
LONDON and MANCHESTER

Decorated Tin Boxes, Canisters, and Aluminium Containers, of British make, manufactured by
THE JOHN DALE MFG COY. NEW SOUTHGATE, LONDON, N.11.

INDEX TO ADVERTISERS—*Continued*

Johnson (S. H.) & Co., Ltd. .....*Cover* iv
Johnson (W. F.) & Co. .....xii, June 21
Jones, Ivor R. xxxi

Kelvin, Bottomley & Baird, Ltd. .....*Cover* ii
Kestner Evap. & Eng. Co., Ltd. x
Key Engineering Co. .....xx, June 14
Kraft Sacks, Ltd. xxxii

Lancaster & Tonge, Ltd. xxxiv
Laporte (B.), Ltd. .....xix, May 24
Lea Recorder Co., Ltd. .....xx, June 14
Leeds & Bradford Boiler Co., Ltd. .....*Cover* ii
Le Grand, Sutcliff & Gell, Ltd. .....v, June 7
Leigh (R. & H.), Ltd. .....*Cover* ii
Leitch (J. W.) & Co., Ltd. xvi
Leitz (E.) (London) .....viii, April 26
Lewis (H. K.) & Co., Ltd. xxxiii
Lilleshall Co., Ltd. .....*Cover* iii
Limmer & Trinidad Lake Asphalt Co., Ltd. xxxiv
Lord (John L.) .....*Cover* iv, June 7

Macinlop, Ltd. .....xi, May 3
Macmillan & Co., Ltd. .....xix, May 24
Manchester Aluminium Co., Ltd. ..xx, June 7
Manlove, Alliott & Co., Ltd. xxxv
Martineau & Smith .....xiii, June 7
McGraw-Hill Publishing Co., Ltd. xxiv
Meldrums, Ltd. xxx
Melingriffith Co., Ltd., The .....xxi, May 24
Metafilters, Ltd. .....xx, May 31
Metcalf & Co. .....xvii, June 21
Methylating Co., Ltd. .....*Cover* iv
Mining & Industrial Equipment, Ltd. xxii
Mitchell (L. A.) xxx
Monel-Weir, Ltd. .....xviii, June 7

Negretti & Zambra .....*Cover* ii, June 14
Neill, W., & Son .....iii, June 7
Nordac, Ltd. .....ii, June 21
Northern Media Supply Co. .....xx, April 26

Oertling (L.), Ltd. xx
Ohlenschlager Bros. .....vi, June 21
Oliver United Filters, Inc. .....xiii, June 21

Page (Chas.) & Co., Ltd. .....xi, June 21
Parker, Tanner & Co., Ltd. .....iv, May 24
Paterson Engineering Co. .....xiv, June 14
Perry & Hope, Ltd. .....xvi, June 21
Pneumatic Conveyance and Extraction (1929), Ltd. .....v, June 7
Potter (F. W.) & Soar, Ltd. iv
Power Gas Corporation, Ltd. .*Cover* iv, June 21
Pragos Engineering Co. .....xiii, June 14
Premier Filterpress Co., Ltd. .....xii, June 21
Price, Stutfield & Co., Ltd. xxv
Prodorite, Ltd. .....xiv, June 7
Pulsometer Engineering Works xxxi

Raschig (Dr. F.) .....*Cover* iii, June 21
Reads, Ltd. .....xvii, June 14
Robinson (F.) & Co., Ltd. .....xix, June 7
Rowlandson (W.) & Co. xxxiii
Royal Metal Trades Pension & Benevolent Society .....xviii, Mar. 1
Rubber Asbestos & Belting Co. ..xxiii, June 14
Ruston & Hornsby xii

Sands, Hunter & Co., Ltd. xxxvi
Scientific Glass Blowing Co. .....xxxiii, April 26
Scott (G.) & Son (London), Ltd. .....*Front Cover*
Siebe, Gorman & Co., Ltd. .....xx, June 14
Sihi Self-Priming Pump Co. xxx
Silica Gel, Ltd. .....xiii, June 21
Simon (R.) & Sons, Ltd. xxxi
Sloog, H. .....xiv, June 14
Sofnol, Ltd. xi
Solvent Products, Ltd. .....i, June 7
Spence, Peter, & Sons, Ltd. .....xix June 14
Spencer, Chapman & Messel, Ltd. xxx
Staatliche Porzellan Manufaktur *Cover* iii, June 21
Staveley Coal & Iron Co., Ltd. .....viii, June 14
Steel Barrel Co., Ltd. .....*Cover* ii, June 21
Steel (J. M.) & Co., Ltd. ix
Stein Bros., Ltd. xxvii
Steward (J. H.), Ltd. xxxiv

Stewarts & Lloyds, Ltd. vi
Storry (G. W.) & Co. .....xvi, June 21
Stott (James), Ltd. .....xviii, May 10
Sutcliffe Bros. & Bryce, Ltd. ..*Cover* iii, June 7

Talbot-Stead Tube Co., Ltd. v
Taw Manufacturing Co., Ltd. ..xxviii, April 26
Tecalemit, Ltd. .....xxxvii, May 24
Tennant (C.) & Co., Ltd. viii
Thermal Syndicate, Ltd. 623
Thom, John xxix
Thompson Bros. (Bilston), Ld. *Cover* iii, June 14
Thornton (A. G.), Ltd. .....xx, June 14
Todd Bros. xxxi
Towers & Co., Ltd. (J. W.) .....xxii, June 14
Trussed Concrete Steel Co., Ltd. *Cover* iv, May 10
Tungstone High Pressure Machine Die Casting Co. .....ii, Mar. 15
Tyrer (Thos.) & Co., Ltd. xx

University Press of Liverpool ..xxxiv, May 24

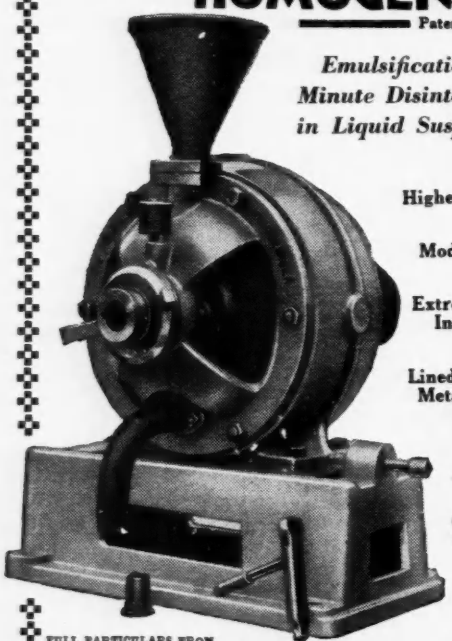
Valor Co., Ltd. .....*Cover* ii, June 21
Viaduct Alum Co., Ltd. .....xv, June 21
Visco Engineering Co., Ltd. xxviii

Walker (James) & Co., Ltd. .....iv, June 7
Wallach Bros., Ltd. .....xix, June 14
Walters (Vincent) .....xvi, June 21
Warrington Chem. & Drug Co., Ld. xvi, June 21
Washington Chemical Co., Ltd. xv
Watson, H. T. xxxi
Waxed Bags, Ltd. .....iii, June 14
Webb, W. A., Ltd. .....xxiii, April 26
Weinreb, F. .....*Cover* iv, June 21
Wengers, Ltd. xxxii
Western Chem. Co. (Paisley), Ltd. xxxiii
West's Gas Improvement Co., Ltd. *Cover* iii, June 21
Wilkinson (James) & Son, Ltd. .....iii, June 7
Wolfe Keene & Co. .....x, June 21
Woolley (Jas.) Sons & Co. .....*Cover* ii, June 14
Wright (Alex) & Co., Ltd. .....xxxvii, May 24

FOR CLASSIFIED INDEX TO TRADES SEE PAGES xxx & xxxi

THE HURRELL HOMOGENISER

Patent 214308



Emulsifications and Minute Disintegrations in Liquid Suspensions.

◆

Highest Efficiency.

◆

Moderate Cost

◆

Extreme Ease of Installation.

◆

Lined with Monel Metal or other alloys.

◆

Automatic Control of Rate of Treatment.

Self Cleaning.

◆

FULL PARTICULARS FROM

G. C. HURRELL & CO., Ltd. Phone: Greenwich 1116

Old School Works, Woolwich Rd., Charlton, S.E.7

SIEVES

We specialise in the manufacture of all types of Sieves and Screens in all sizes and grades of mesh. In addition to Woven Wire sieves we are makers of Swiss Silk Bolting Cloth, Perforated Metal and Horse Hair bottomed sieves.

REPAIRS Our large stocks of Woven Wire, etc., enable us promptly to effect all repairs and also, to match accurately the size of the worn or damaged mesh. We collect and deliver in the London Area and pay return carriage on Provincial orders.

Price List on Application.

F. W. POTTER & SOAR, Ltd.

PHIPP STREET - LONDON, E.C.2

Telegrams: "Wirework, Finsquare, London." Telephone: Bishopsgate 2177 & 2178

WIRE GAUZE

Fine Wire Cloth *Heavy Screening*

Made in
ALL MESHES
ALL METALS
ALL STRENGTHS

The Woven Wire section of our catalogue contains much useful technical information relative to Wire Sieving. We shall be pleased to forward a copy on request.

Manufacturers of all kinds of WIRE PRODUCTS for the Chemical and Allied Industries.

BOTTLE BASKETS, TRAYS, MACHINERY GUARDS, &c.

CORROSION—A REMEDY

Many people in the Chemical Industry, troubled for years by corrosion of tubes, have found a solution to their difficulties by using seamless tubes of the Staybrite type and other Chromium Nickel steels.

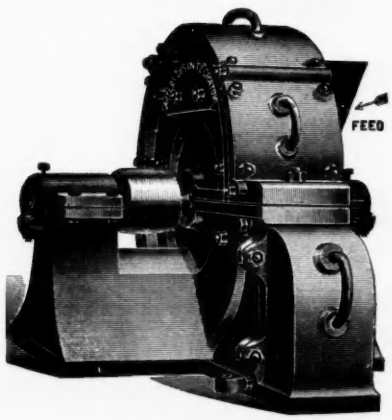
These tubes have proved to be more economical than steel and the expensive compositions used in some chemical plants.

You will find it worth while to investigate their possibilities.

TALBOT-STEAD TUBE CO., LTD.
Birchills - Walsall

Telephone: 4186-4190 (5 lines)
Telegrams: "Talbot Phone, Walsall"

Disintegrating & Dressing *for the* CHEMICAL TRADE



Thousands of these machines are working in all parts of the globe, grinding, granulating and shredding and dressing all kinds of material, animal, vegetable and mineral. For particulars send to Head Office.

★ *Fifty years knowledge in every machine*

Harrison Carter *of* Dunstable

Head Office Dunstable, England London Office: 12, Mark Lane, E.C.3

COILS

OF EVERY DESCRIPTION MADE FROM WROUGHT IRON AND STEEL TUBES

SPECIAL COIL OF STEEL TUBE 2" NOM. BORE IN ONE CONTINUOUS LENGTH.

Difficult Coils a Specialty.

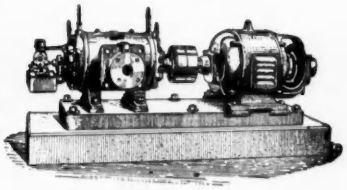
STEWARTS AND LLOYDS LTD

GLASGOW : BIRMINGHAM : LONDON

BURCKHARDT

VACUUM PUMPS

in all sizes.



COMPRESSORS

for all purposes.

Complete plants for the compression and liquefaction of air and gases.

Prompt delivery of standard sizes.

Works: Basle, Switzerland 26, Victoria Street, S.W.1

THE BURCKHARDT ENGINEERING WORKS.

VALVES AND FITTINGS
for gas, steam, water or air services.

CAST IRON VALVES AND COCKS
for all services and purposes.
Quick delivery guaranteed

BRITISH STEAM SPECIALTIES, LTD.

Wharf Street, LEICESTER

DORRCO

DORR SYSTEM OF CONTINUOUS RECAUSTICIZING IN SODA PULP AND KRAFT MILLS

WHAT THE SYSTEM MEANS:—

Uniformity of operation. All materials handled mechanically.
Reduced labour charges. Low upkeep costs.
Small floorspace requirements.
An installation of equipment of proved performance.

THIS SYSTEM HAS BEEN ADOPTED BY THE LARGEST SULPHATE PULP MILL IN EUROPE WITH EXCELLENT RESULTS.

Write for further particulars.

The DORR COMPANY, LTD.

Engineers,

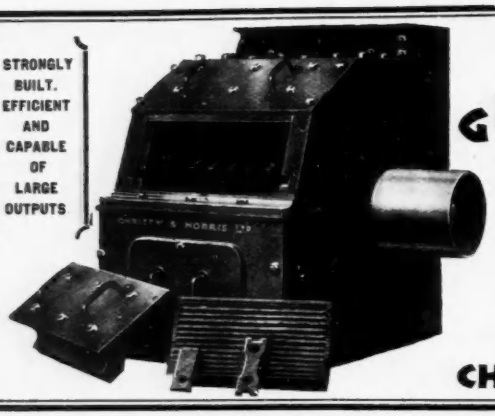
ABFORD HOUSE, Wilton Road (Victoria), LONDON, S.W.1

DORR GESELLSCHAFT m.b.H., Kielganstrasse 1, Berlin, W. 62.
SOUTH AFRICA: E. L. Bateman, Locarno House, Johannesburg

THE DORR COMPANY, 247, Park Avenue, New York City, U.S.A.

SOCIÉTÉ DORR et Cie., 26-28, Rue de la Pépinière, Paris, VIII.
AUSTRALIA & NEW ZEALAND: Crossle & Duff Pty., Ltd., 360, Collins Street, Melbourne.

STRONGLY BUILT. EFFICIENT AND CAPABLE OF LARGE OUTPUTS



GRINDING MACHINERY
FOR ALL PURPOSES

Disintegrators and Pulverisers suitable for grinding Chemicals of all descriptions; Fertiliser, including Bones, Horns and Hoofs; Drugs, etc.

Specialists in the manufacture of Grinding Machines, Christy & Norris, Ltd., are able to offer an extensive range of models covering all possible needs. Whether you require a small Grinding Machine, one of medium capacity, or a type capable of many tons per hour output, you will find just what you want in the C. & N. range.

Illustrated Catalogues Free on application.

CHRISTY & NORRIS, LTD., CHELMSFORD

PLATINUM LABORATORY APPARATUS

CRUCIBLES
· DISHES ·
CAPSULES
BOTTLES

Write for Illustrated List :—
"Platinum, Gold, and Silver."

JOHNSON MATTHEY & CO. LTD.
73 - 83
HATTON GARDEN
LONDON E.C.1

Industrial Chemicals
of every description
for Home and Export

Formaldehyde 40%
Antimony Oxide 98/100%

PLEASE SEND US YOUR ENQUIRIES.

Paraffin Wax and Scale, all grades; also Candelilla and Spermaceti.

CHARLES TENNANT & CO., LTD.
CHEMICAL MANUFACTURERS AND MERCHANTS,
93, West George Street, GLASGOW.
Telegrams: "Tennant, Glasgow." Telephones—6617-8 & 9 Central.
DUBLIN. Works: Anniesland, Glasgow. BELFAST.

SOLVENTS

and

PLASTICISERS

for

Nitro Cellulose

Cellulose Acetate

Cellulose Ethers

Full particulars, quotations and samples may be obtained from:

J. M. STEEL & CO., LTD.

Head Office:
"Kern House,"
36/38, Kingsway,
LONDON, W.C.2
Holborn 2532-4

Branch:
Calder Street,
Lower Mosley Street,
MANCHESTER
Central 0524

Telephones:

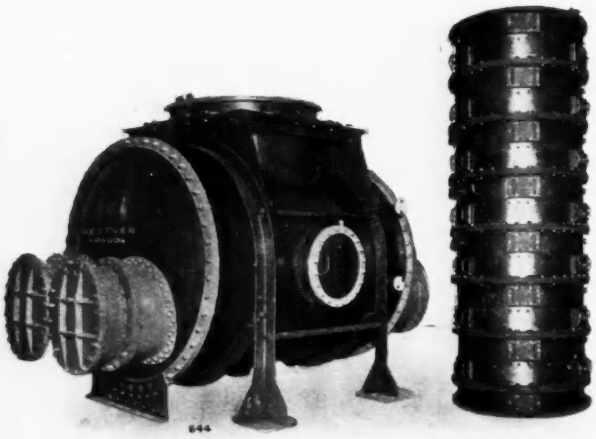
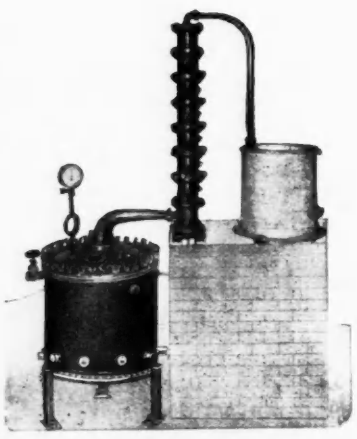


Photo. of Kestner Continuous Steam - heated Fractionating Still in course of erection.

Kestner Chemical Plant for Solvents

★

KESTNER EVAPORATOR & ENGINEERING CO. LTD.
Chemical Engineers,
5, GROSVENOR GARDENS,
WESTMINSTER, LONDON, S.W.1



Kestner Patent Oilectric Unit System with Fractionating Still.

SOFNOL LTD · WESTCOMBE HILL, GREENWICH, S.E.10 ·

"Talk it over with Sofnol"

TELEPHONE
Greenwich 1600-1

NOT MERE LIME

IMMENSE practical advantages distinguish Sofnol Calcium Hydrate from mere lime. And of these, perhaps, the Chemist most appreciates uniformity. Sofnol Calcium Hydrate is a technically pure chemical entity capable of quantitative application.

For water treatment, CO_2 precipitation, neutralisation generally, and use in place of more expensive soda, test Sofnol Calcium Hydrate. Its lightness, solubility and freedom from grit will interest you. We gladly send a free sample.

Sofnol
LIMITED
WESTCOMBE HILL
GREENWICH
S.E.10

CALCIUM HYDRATE

TAS/wt. 40

PITCH

ROAD TAR

(BECSPRAY AND BECGROUT)

CREOSOTE NAPHTHALINE

(IN VARIOUS FORMS)

Green Oil. Anthracene.
Disinfecting Fluid.
Green Copperas (Ferrous Sulphate)
Black Varnish.
Liquid Ammonia.
Sulphate of Ammonia.

Naphthas. Xylole.
Toluole. Pyridine.
Crystal Carbolic Acid (39/40° C).
Liquid Carbolic Acid (Cresylic Acid).

BALLOON BRAND

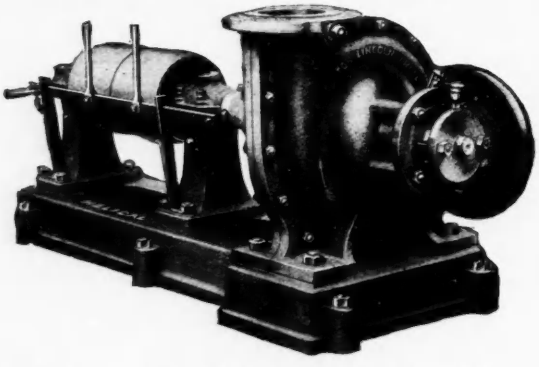
The GAS LIGHT & COKE CO

DAUNTSEY HOUSE, FREDERICK'S PLACE, OLD JEWRY, LONDON, E.C.2.
Telephones: METROPOLITAN 9362, 9363, 9364.
Telegrams: "Blangus, Thread, London."

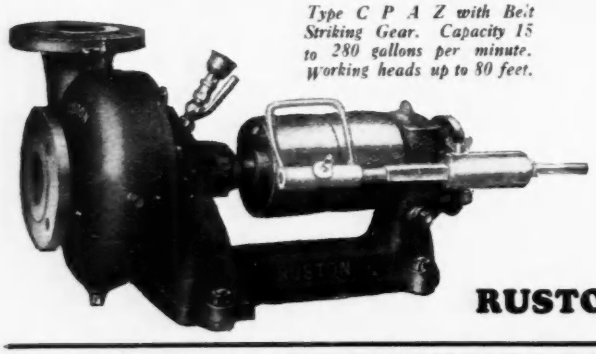
RUSTON

Centrifugal Pumps

for all Services and Outputs



Type C P H R with fast and loose pulleys. Capacity 90 to 5200 gallons per minute. Working heads up to 50 feet.



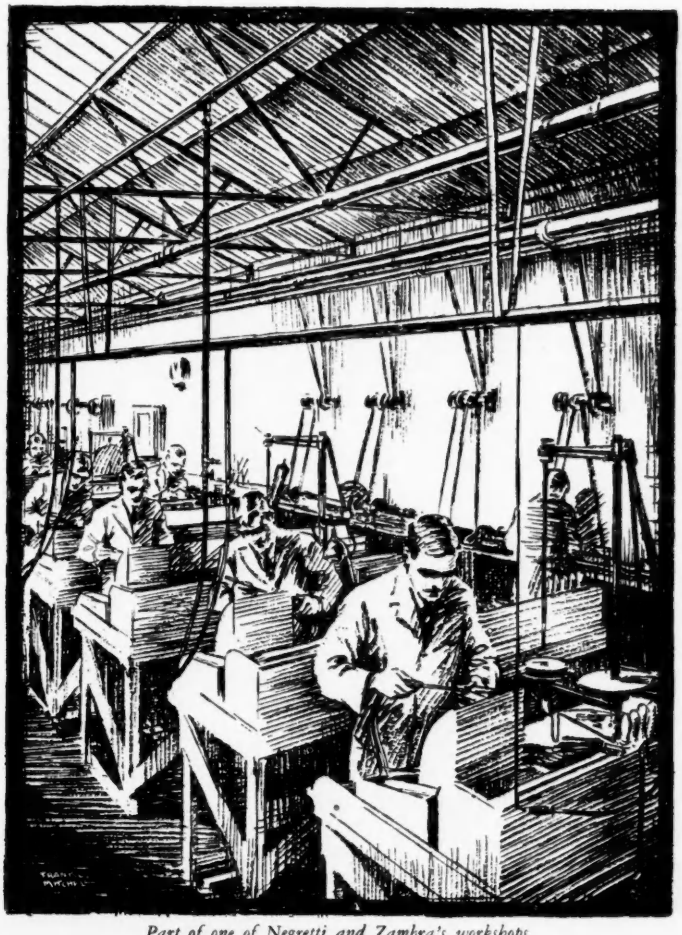
Type C P A Z with Belt Striking Gear. Capacity 15 to 280 gallons per minute. Working heads up to 80 feet.

THE RUSTON range of centrifugal pumps is designed to meet the continual demand for a pump of sound construction and high efficiency at a low price. Our enormous output enables us to produce the right class of pump at the right price.

Particulars of Standard patterns for Heads up to 200 feet and outputs of 21,000 gallons per minute on application.

RUSTON & HORNSBY Ltd., LINCOLN

NEGRETTI AND ZAMBRA RELY ON GAS....



Part of one of Negretti and Zambra's workshops where gas is used for many scientific processes

Accuracy! Reliability! You are sure of these qualities in every instrument made by Negretti and Zambra. Why? Because their scientific staff uses modern equipment *and a really up-to-date fuel.* Because they move with the times. For their heating and calibrating operations they use gas—the accurate, dependable fuel. The fuel for every industrial heating process —large, small, simple or delicate. Wouldn't gas help you?

If it's heat you want it's gas you want

GAS

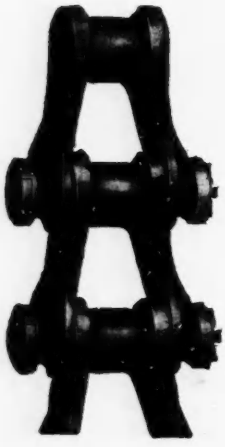
THE FUEL OF THE FUTURE

The B.C.G.A., ... representing the British Gas Industry, is at your service for free advice and help on the industrial uses of gas.

THE BRITISH COMMERCIAL GAS ASSOCIATION, 28, GROSVENOR GARDENS, LONDON, S.W. 1

I.3

"B.B." CHAINS



"B.B." BUSHED CHAINS
Suitable for large Elevators and slow-speed drives

MANY OTHER TYPES ALSO MADE

BAGSHAWE
DUNSTABLE & CO., LTD.

C.A.18

WOOD VATS & TANKS
SPECIALISTS SINCE 1766

WOOD VESSELS FOR LIQUIDS SUITABLE FOR ALL TRADES, 50 to 150,000 GALLON CAPACITY.

* * *

DYE VATS & TANKS OF ALL DESCRIPTIONS.

* * *

VESSELS FOR CHEMICAL WORKS IN ALL SIZES AND SHAPES.

* * *

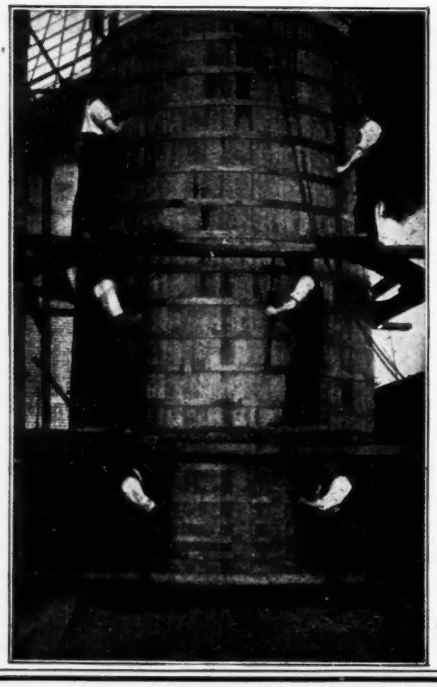
LEAD LINED TANKS WITH PROPERLY BURNT JOINTS.

* * *

CIRCULAR BOILING VATS, WOODEN PRESSURE VATS, VACUUM BOTTLES, ETC.

* * *

HIGH CLASS RELIABLE WORK.



CARTY & SON, LIMITED
HARDERS ROAD, PECKHAM, LONDON, S.E.15
Telephone: NEW CROSS 1826

PATTINSONS MAGNESIA

Laboratory samples and bulk deliveries...

PATTINSONS Magnesia made by the Washington Chemical Company is the same whether it comes to you in a bottle as a laboratory sample or in lorry or truck-loads as a bulk delivery. Experience of Magnesia Manufacture gained in originating the Pattinson Process and in manufacturing vast quantities during the past 89 years, ensures the highest quality.

PM5-202

PATTINSONS MAGNESIA REGD. TRADE MARK

Pattinsons Magnesia in its various forms is unrivalled for purity, lightness, texture and freedom from moisture. For industrial and pharmaceutical purposes, Pattinsons Magnesia can always be relied upon for chemical purity and physical uniformity.

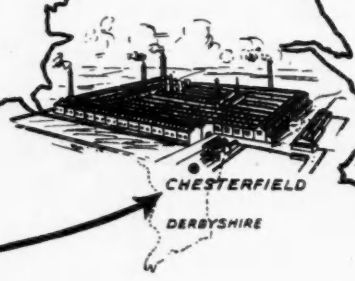
Write for sample to the sole manufacturers

THE WASHINGTON CHEMICAL Co. LTD.,

WASHINGTON STATION · COUNTY DURHAM · ENGLAND

The home of the original **PATTINSON PROCESS** *for the production of the finest grades of magnesia*

Send your enquiries for Weldless Steel Cylinders here



SOLID DRAWN STEEL CYLINDERS FOR THE STORAGE OF OXYGEN HYDROGEN, NITROGEN, COAL GAS, METHANE, SULPHUROUS ACID CARBONIC ACID NITROUS OXIDE, AMMONIA, CHLORINE, PHOSGENE, ACETYLENE, ETC., ETC.

CTCO

THE CHESTERFIELD TUBE CO LTD

TELEPHONE: Milnsbridge 189 & 190.

TELEGRAMS: Leitch, Milnsbridge.

NITROXYLOL, BINITROXYLOL
BINITRONAPHTHALENE
NITRONAPHTHALENE
BINITROBENZOL
NITROBENZOL
XYLIDINE, M.&P. XYLIDINE
ORTHO & PARA NITROTOLUOL
BINITROTOLUOL (All Grades)
PARA NITRO ORTHO TOLUIDINE
META NITRO PARA TOLUIDINE
ORTHO TOLUIDINE
PARA TOLUIDINE

EXTENSIVE RANGE OF
OIL COLOURS
ACID COLOURS
BASIC COLOURS
DIRECT COLOURS
PIGMENT COLOURS
AZOIC COLOURS FOR WOOL
ALSO COLOURS SUITABLE FOR ALL TRADES
META TOLUYLENE DIAMINE
META PHENYLENE DIAMINE

JOHN W. LEITCH & Co. Ltd
MILNSBRIDGE CHEMICAL WORKS
REGD TRADE MARK
NEAR HUDDERSFIELD

FAST BASES FOR ICE COLOURS
ANILINE DYES
INTERMEDIATE PRODUCTS

SCOTLAND:
KIRKPATRICK & LAUDER, LTD.
179, WEST GEORGE ST.
GLASGOW, C2.

CANADA:
PRESCOTT & Co. REG'D.
637, CRAIG ST. WEST,
MONTREAL, QUE.

SEITZ'
Alluviation Filters

ARE NOW INTRODUCED AND ADVERTISED TO THE CHEMICAL TRADE IN THE UNITED KINGDOM AFTER HAVING RECENTLY BEEN ADOPTED BY THE LARGEST CHEMICAL WORKS ON THE CONTINENT. THEY HAVE SOLVED INNUMERABLE FILTRATION PROBLEMS AND THEY ARE DEFINITELY A SUCCESS.

Removing the Filtering Layer from one of the Frames of a medium sized Filter.

EXPERIMENTS AND TEST FILTRATIONS CARRIED OUT CONFIDENTIALLY IN MY LABORATORY BY *A QUALIFIED CHEMIST FREE OF CHARGE.*

⌘ ⌘ ⌘

Sole Importer:

JOHN C. CARLSON
149, FARRINGDON RD., LONDON, E.C.1

Telephone: CLERKENWELL 9077.

Telegrams: "ELCAFILT, LONDON."

B

TO INTEREST SULPHURIC ACID MANUFACTURERS

CONTACT PROCESS

FOR THE CONVENIENCE OF OUR MANY FRIENDS A MOTION PICTURE FILM OF MONSANTO CONTACT SULPHURIC ACID PLANT MAY BE SEEN AT OUR LONDON OFFICE.

VIEWS OF THE CONTACT SULPHURIC ACID PLANT OF MONSANTO CHEMICAL WORKS AT ILLINOIS, U.S.A. . . . . .

■ ■ ■

MONSANTO CHEMICAL WORKS WERE THE FIRST to develop this wonderful discovery, and their claim for process and product under Patent No. 1,657,754 has been upheld in the UNITED STATES COURTS.

A VISIT to one of the largest Sulphuric Acid Manufacturers in the Country, a user of MONSANTO CATALYST, can be arranged.

MONSANTO VANADIUM CATALYST
British Patent № 266007

COST	A mere fraction of the cost of platinum contact mass.
CONVERSION	Equal to platinum in all cases—higher in most.
STABILITY	Not affected by chlorine or arsenic. Needs no renewing after long periods.
INSTALLATION	Not necessary to change your present equipment; can be used in any converter.
PROVED	In three years' commercial operation.

GRAESSER-MONSANTO
CHEMICAL WORKS LTD.
VICTORIA STATION HOUSE
VICTORIA STREET
LONDON
S.W.1.

WORKS:
RUABON, NORTH WALES
WEAR TAR WORKS
SUNDERLAND

ASSOCIATED WORKS:
ST. LOUIS
U.S.A.

COMMERCIAL SOLVENTS CORPORATION

(INCORPORATED IN MARYLAND, U.S.A.)

REGISTERED TRADE MARK.

SOLVENTS

BUTANOL *(Normal butyl alcohol)*

A component of all good lacquer. Notable for increasing flow and resistance to blush.

DIBUTYL PHTHALATE

The universal lacquer plasticizer—has no residual odour—does not discolour white pigments—compatible with gums.

BUTYL STEARATE

Plasticizing and softening agent. Particularly interesting to leather and leather cloth trade.

BUTALYDE *(Normal butyl aldehyde)*

An anti-oxidant; manufacturing rubber accelerators; synthetic resins.

ACETONE *(B.G.S.)*

Universal solvent—no residual odour—synthetic resins—Paint and Varnish removers.

DIACETONE ALCOHOL

High boiling solvent for brushing and striping lacquers.
Anti-freeze agent—manufacturing artificial leather dopes.

METHANOL—*Synthetic*

Solvent for gums and resins—manufacture of formaldehyde.

LONDON OFFICE

ALDWYCH HOUSE, ALDWYCH, W.C.2.

Telephone: HOLBORN 1996.
Telegrams: BUTANOLIST-PHONE, LONDON.

Cables: COMSOLVENT, LONDON
COMSOLVENT, NEW YORK.

OFFICES AND WORKS:
TERRE HAUTE, INDIANA, U.S.A.
PEORIA, ILLINOIS, U.S.A.

EXECUTIVE OFFICES:
NEW YORK CENTRAL BLDG.
230, PARK AVENUE
NEW YORK CITY, U.S.A.

"STERLING BRAND"

CHEMICALS

for Purity and Reliability

ANALYTICAL AND RESEARCH CHEMICALS

RUBBER CHEMICALS AND PIGMENTS

CHEMICALS FOR OILS, PAINTS ETC.

PHARMACEUTICAL CHEMICALS

BISMUTH SALTS
SCALE PREPARATIONS
CITRATES BROMIDES
HYPOPHOSPHITES
ETHER, ETC.

PHOTOGRAPHIC CHEMICALS

GLASS AND CERAMIC CHEMICALS ETC.

We invite enquiries for any Special Chemical or Material you may require.

THOMAS TYRER & CO., Ltd.

STIRLING CHEMICAL WORKS

Telephone: Maryland 2510

STRATFORD
LONDON, E.15

Telegrams: "Tyremicus, Phone, London"

The FULLEST★ RANGE of BRITISH BALANCES

★ By a standard of skilled craftsmanship consistently applied for over eighty years, we have been able to win a first place for the British Balance in the markets of the world. The name "Oertling" on a balance is a world-accepted hall mark of precision and reliability, and to-day our range covers standard instruments for every requirement in analytical and assay work. ★Latest developments include special Aperiodic and Micro-Balances of the utmost precision. We manufacture also many grades of heavier instruments for ordinary laboratory use, and offer the widest experience in the design and construction of balances to users' requirements. ★Please write now for our list of Chemical Balances, or, better, call at our Showrooms for free demonstration. The list illustrates no less than twenty-four distinct types, each at the lowest price consistent with our standard of workmanship.

PRECISION TORSION BALANCE

For textile work, etc. Special balances built for every scientific and industrial use—let us know your needs.

Oertling

L. OERTLING LTD.

BRITISH DESIGN-CRAFTSMANSHIP-CAPITAL

Showrooms:
65, HOLBORN VIADUCT
LONDON
E.C.1

TAS/Or.67.

New Product from Welsh Mine

Messrs. INSOLES LTD.

Cymmer Collieries

PORTH, GLAM., SOUTH WALES

offer large and regular supplies of

NATURAL

METHANE GAS

Analysis
CARBON DIOXIDE 0·67%
*COMBUSTIBLE GAS 97·19%
NITROGEN (by difference) 2·14%
*Nearly pure Methane

output from their own mine

20,000 cu. ft. per day

Supplied in Cylinders of 150 cu. ft. at 700/800 lbs. pressure. Purchaser to supply cylinders and pay carriage both ways.

LARGE QUANTITIES AT REDUCED RATES.

For Prices and any other Information required apply Geo. Insole & Son, Cardiff.

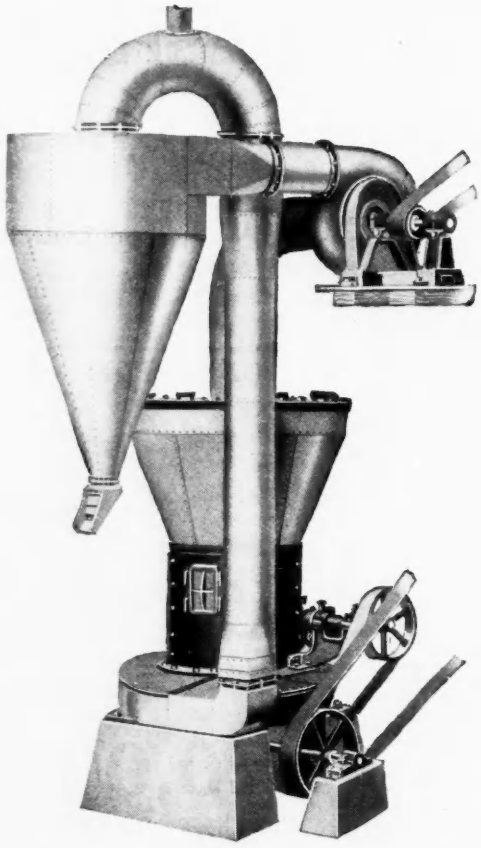
Used for :—
Flame Safety and Electrical Lamp Testing. Chemical Synthesis and General Research. Aviation.

Or at source for the manufacture of

METHYL ALCOHOL & FORMALDEHYDE

DUSTLESS GRINDING

RAYMOND Mills grind, classify and convey in one operation, thereby eliminating Bolting Cloths, Reels and Internal Screens, and their attendant faults. Sticky materials are being successfully ground with these Mills.



Among well-known users of Raymond Mills may be mentioned :

Washington Chemical Co.
British Dyestuffs Corporation.
Nobel Industries Ltd.
National Titanium Pigments, Ltd.
British Alizarine Co., Ltd.

THE RAYMOND SYSTEM IS ABSOLUTELY DUSTLESS IN OPERATION

We have the largest and most up-to-date Test Plant in Europe at our Derby Works, and invite you to send us a sample of your material for testing. You will be under no obligation.

Write for the new Catalogue No. R. 200.

MINING & INDUSTRIAL EQUIPMENT LTD
ASSOCIATED WITH — INTERNATIONAL COMBUSTION LTD.
11, Southampton Row, London, W.C.1.
Works: Derby & Frith.

TELEPHONE : HOLBORN 7277 (3 LINES)

TELEGRAMS & CABLES : HARDRAYMILL WESTCENT LONDON

RAYMOND

"THE ACE OF QUALITY"

Please write for full list.
Samples on Request.

Telephone: 3040-8.
Telegrams: "Tyche Fen, London"

HONEYWILL BROS., Ltd.

79 MARK LANE, LONDON, E.C.3

PRODUCTS

Six Products of Outstanding Merit used very extensively in the Textile & Leather Industries

RESISTONE K
A Resist for Animal Fibres and Acetate Silk against Cotton Dyestuffs.

RESISTONE O
A Mordant for Basic Colours on Cotton and all Cellulose Fibres.

TEXOGENT
Still the supreme solvent for scouring and general cleansing of all woollen and cotton fabrics, raw wool, yarns, hosiery, etc. Also in the laundry industries.

TEXOGENT, "L"
For assisting pigment penetration in the Leather Industry without destroying the natural grain.

G.B. WATERPROOF LEATHER FINISHES
Special non-cracking finishes, rendering the leather fast to wet and dry rubbing.

SPECIAL CHROME LIQUOR
Having distinct advantages and of exceptional interest to all Chrome Tanners.

Please write us for full particulars.

GLOVER BROS
(LEEDS) LTD.
Chemical Department
WORTLEY LOW MILLS
Telegrams: Glovers, Wortley, Leeds
LEEDS
Telephone: 38037 (two lines)
LONDON, 1, Gresham Street, E.C.2

New Edition—Now Ready.

Elements of Fractional Distillation.

NEW SECOND EDITION.

By Clark S. Robinson, Associate Professor of Chemical Engineering, Massachusetts Institute of Technology. *International Chemical Series.* *255 pages, 5½×8, 91 illustrations* ..... *Price* **15/-** *net.*

A thorough revision of a book that explains the principles of practical distillation simply and accurately according to the best ideas of physical chemistry and chemical engineering. This revision includes material on the vaporisation and rectification of complex hydrocarbon mixtures, natural gasoline and petroleum; on the weathering of natural gasolin, and on the efficiencies of rectifying columns.

CONTENTS: I. The Phase Rule. II. One Component Systems. III. Two Component Systems. IV. More Complex Systems. V. The Gas Laws. VI. Solutions. VII. Concentrated Solutions. VIII. Simple Distillation and Partial Condensation. IX. Fractionation. X. Rate of Fractionation. XI. Discontinuous Distillation. XII. The Design of a Continuous Still. XIII. The Fractionating Column. XIV. The Condenser. XV. Accessories. XVI. Continuous Distillation. XVII. Ammonia. XVIII. Benzolised Wash Oil. XIX. Methyl Alcohol. XX. Ethyl Alcohol. XXI. Rectification of Complex Mixtures. XXII. Rectification of Complex Hydrocarbon Mixtures. XXIII. Rectification of Natural Gasoline. XXIV. Simple Distillation. XXV. Topping Stills for Crude Petroleum.

Solutions of Electrolytes With Particular Application to Qualitative Analysis.

By Louis P. Hammett, Associate Professor of Chemistry, Columbia University. *International Chemical Series.* *211 pages, 5½×8* ..... *Price* **11 3** *net.*

This book makes effective use of qualitative analysis as a means of teaching the general principles relating to the behaviour of solutions of electrolytes. The first part of the book presents principles; the second part gives experiments illustrating and developing the principles. The book is intended for one-semester courses.

CONTENTS: Part I. Principles. I. Introduction. II. Strong Electrolytes. III. The Solubility Product Principle. IV. Weak Electrolytes: The Law of Chemical Equilibrium. V. Hydrolysis. VI. Complex Compounds. VII. Oxidation-Reduction Reactions. VIII. Complex Oxidation Reduction Reactions. Part II. Experiments. A. The Course of Laboratory Instruction. B. The Method of Analysis. C. Special Notes on the Method of Analysis. Appendices.

McGRAW-HILL PUBLISHING CO. LIMITED.
6, Bouverie Street - - London, E.C.4

RECOVERY OF SOLVENTS

WITH
ECONOMY — EFFICIENCY — SAFETY
IN INDIA RUBBER WORKS
ACETATE & NITRO RAYON WORKS
CELLULOID WORKS, &c.
by the
ACTIVATED CARBONS & PATENT PROCESSES

"ACTICARBONE"

REGISTERED TRADE MARK.

Extraction from
COAL AND OIL GAS

PLANTS INSTALLED

PRICE, STUTFIELD & Co. LIMITED

6 FENCHURCH BUILDINGS, LONDON, E.C.3

Telephone: Monument 1406 Telegrams: Exconsec, Fen., London

Representing—
Société de Recherches et d'Exploitations Pétrolifères, Paris

C

THE CHEMICAL PRODUCTS OF I.C.I.

DENATURANT METHANOL

A Solvent free from Excise Restrictions

SYNTHETIC methyl alcohol denatured in accordance with the demands of H.M. Customs and Excise, and therefore free of all Excise restrictions, is now manufactured at the Billingham Factory of Imperial Chemical Industries Limited.

Its constant composition and the fact that it contains over 99% of methanol render it particularly suitable for the methylation of ethyl alcohol and also for use as a solvent in processes which are thereby free of Excise control.

Full information and prices may be obtained from any I.C.I. Sales Office.

IMPERIAL CHEMICAL INDUSTRIES LIMITED

IMPERIAL CHEMICAL HOUSE, LONDON, S.W.1

Sales Offices at: Belfast, Birmingham, Bradford, Bristol, Dublin, Gateshead-on-Tyne, Leeds, Leicester, Liverpool, London, Manchester

Agents for Scotland: Arthur & Hinshaw Ltd., 4 Blythswood Sq., Glasgow

C.126

R. W. Greeff & Co. Ltd.

THAMES HOUSE, QUEEN STREET PLACE

LONDON, E.C.4

Telegraphic Address: *"Greeff, Cannon, London."*

Telephone *City 6550 (8 lines)*

and at:—
Parsonage Chambers, 3, Parsonage, MANCHESTER.

NEW YORK:—
R. W. GREEFF & Co., Inc., 10, East 40th St.

ACETONE
ACID ACETIC
ACID FORMIC
ACID OXALIC

BORAX
BORACIC ACID *(All Grades)*
CELLULOSE ACETATE
FORMALDEHYDE
LEAD ACETATE BROWN
LEAD ACETATE WHITE
POTASH BICHROMATE
SODA ACETATE
SODA BICHROMATE
SODA CHLORATE
SODA NITRITE
SODA PRUSSIATE

Complete range of Chemicals, Intermediates and Solvents for all trades. Enquiries Solicited.

We have specialized in SOLVENTS of various kinds for over 50 years. Recently Lacquers, both Cellulose Nitrate and Acetate, have opened up a wider field, to the expansion of which we have made our contribution.

A further increase in consumption of Lacquers should be the aim of all interested in this branch of the finishing industry.

Our contribution to this is to offer those solvents which in our opinion will show improved quality with lower prices.

We suggest for your investigation :—

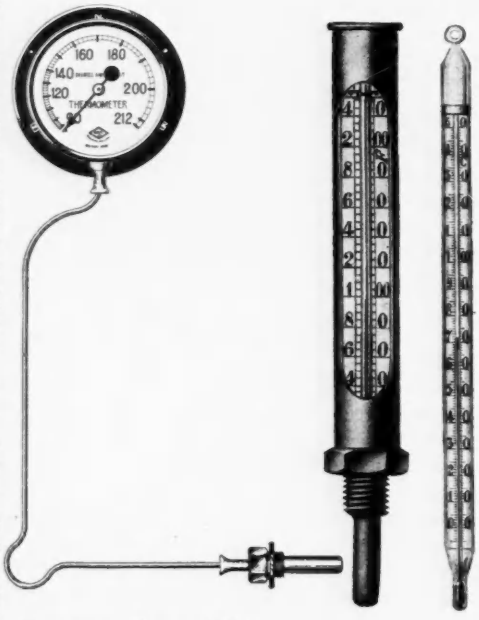
PENTASOL TERTIARY AMYL ALCOHOL PENTEXEL
SECONDARY BUTYL ALCOHOL SECONDARY BUTYL ACETATE
GLYCOL ETHERS

HIGH AND LOW BOILING SPECIAL SOLVENTS FOR ALL PURPOSES

STEIN BROTHERS LIMITED

OCEAN HOUSE, 24/5 GT. TOWER STREET, LONDON, E.C.3

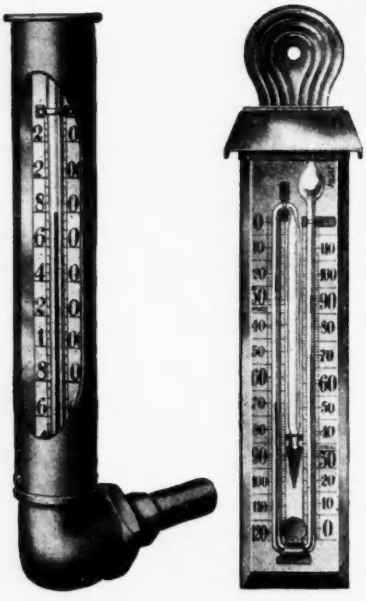
INSTRUMENTS OF ACCURACY



We specialise in the manufacture of all types of
THERMOMETRICAL INSTRUMENTS
and
PRESSURE, VACUUM, &c. GAUGES
and would welcome your enquiries, as we are confident of our ability to give you the utmost satisfaction on price, quality and prompt delivery.

REPAIRS to any make of mechanical instrument carried out economically and promptly.

THE ACCURATE RECORDING INSTRUMENT Co., Ltd., Manor Road, TEDDINGTON, Middlesex.



TELEPHONE: *Kingston 6264-5.*

TELEGRAMS: *"Accuracy, Teddington."*

Make your Works Safe from Explosions

A factory in which the atmosphere is charged with dust is unhealthy, and when this dust is combustible, there is always the risk of explosion and fire.

Ensure the health of your workers, and, at the same time, eliminate the fire hazard by installing

VISCO-BETH DUST COLLECTORS

These will reclaim, *at the source of origin*, almost 100% of the dust arising from grinding mills, mixers, bagging machines, and your works will be as clean as a new pin. In almost every case it pays to salvage the dust now wasted.

Write for particulars.

VISCO ENGINEERING CO., LTD., 162, *GROSVENOR ROAD, WESTMINSTER, S.W.1*

Also Makers of VISCO Air Filters and VISCO Cooling Towers.

BROTHERTON
AND COMPANY LTD.
LEEDS

LIQUOR AMMONIA
All Strengths
SULPHATE OF AMMONIA
COAL TAR PRODUCTS
SULPHURIC ACID
SULPHUR DIOXIDE
Anhydrous
DYESTUFFS
METACHROME
AFTERCHROME
ACID BASIC VAT

BICARBONATE of AMMONIA
CARBONATE of AMMONIA
PICRIC ACID SALTCAKE
MURIATIC ACID
SODIUM BISULPHITE
HYDROSULPHITES
SODIUM HYDROSULPHITE
FORMOSUL ZINC FORMOSUL
LAUNDROS LEUCOTROPES

TELEGRAMS Brotherton Leeds
TRADE MARK
TELEPHONE Leeds 20024

ARTESIAN WELLS and BORE HOLES
1000
gallons of water
can be raised 100 ft. at less than 1D. !

One of our customers saved in the first year 80% of the first cost of Plant. We may be able to do this for you.

We shall be glad to give advice and submit a complete scheme without any obligation on your part.

WATER SUPPLIES
JOHN THOM
CANAL WORKS PATRICROFT ENGLAND

TRADE GUIDE

ACIDS

OLEUM (all strengths)

Sulphuric Battery Dipping
Muriatic Nitric

SPENCER CHAPMAN & MESSEL, LTD.

With which is amalgamated WILLIAM PEARCE & SONS, LTD.
WALSINGHAM HOUSE, SEETHING LANE, E.C.3
Telephone: Royal 1166 Works: SILVERTOWN, E.16
Telegrams: "Hydrochloric, Fen, London"

ANALYTICAL REAGENTS

B. D. H. CHEMICALS

FOR ANALYTICAL WORK

THE BRITISH DRUG HOUSES, LIMITED.
Makers of Fine Chemicals
GRAHAM STREET, LONDON, N.1

BAKELITE AND SYNTHETIC MOULDINGS

ASHDOWN

BAKELITE MOULDINGS FOR THE CHEMICAL AND ARTIFICIAL SILK ETC., INDUSTRIES.

ASHDOWN MOULDINGS in Bakelite and other synthetic resins are made in one of the most up-to-date plants in the country to the highest standard of accuracy under expert supervision.

Send us your Moulding problems. If it is possible ASHDOWN will mould it.

H.E. ASHDOWN (B'ham.), Ltd., Perry Barr, B'ham.

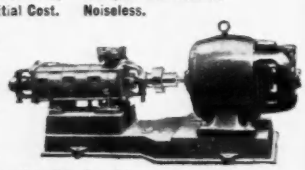
CENTRIFUGAL VACUUM PUMPS

A CENTRIFUGAL VACUUM PUMP

No Valves. No Pulsations. Compact and Robust. Low Initial Cost. Noiseless.

Gives constant capacity vacuum up to 95 per cent. of barometric reading; 99·6 per cent. against closed suction. Handles liquids as readily as air.

OTHER SIHI SPECIALITIES
Self Priming Centrifugal Pumps. List RB.
Centrifugal Air Compressors. List KA.
Automatic Domestic Water Plant. List AA.



Write for Leaflet L1
THE SIHI SELF PRIMING PUMP CO.
Standish Road, Fallowfield, MANCHESTER

CHEMICAL PLANT AND MACHINERY

CS_2 PLANTS——

CONSTRUCTION & STARTING UP OF COMPLETE MODERN CARBON BISULPHIDE PLANTS.
NEW FURNACE PLANTS AND IMPROVEMENT OF EXISTING INSTALLATIONS A SPECIALITY
ZAHN & CO., LTD., BERLIN, W.15
Specialist Engineers for Chemical Plant
Founded 1881
Representation for British Empire:
L. A. MITCHELL, A.M.I.Mech.E.
Harvester House, 37 Peter Street, MANCHESTER

MELDRUM
REFUSE DESTRUCTORS
WITH HEAT UTILISATION

Keep Works Clean
Lower Insurance
Accelerate Output

MELDRUMS, Ltd., Timperley, Manchester

CHEMICALS

SPECIALITIES:

LIME BISULPHITE, 1060 & 1070
SODA BISULPHITE, SOLUTION
ACID SULPHUROUS,
CALCIUM CHLORIDE, PURE CRYST.
CALCIUM CHLORIDE, FUSED
CALCIUM CHLORIDE, FUSED POWDER
DRY CALCIC SULPHITE, 42 SO$_2$
POWDERED SILICA

BENNETT & JENNER, LTD., *Manufacturing Chemists,*
ABBEY LANE, STRATFORD, LONDON, E. *Telephone: Maryland 2058*

TRADE GUIDE

CHEMICALS

CARBONATE of AMMONIA
PRECIPITATED CHALK
(extra light)

BROTHERS CHEMICAL CO. (1922) LTD.
TRAFFORD PARK, MANCHESTER

DRYING MACHINES

DRYING MACHINES

AUTOMATIC AND CONTINUOUS TEMPERATURE UNDER PERFECT CONTROL

RICHARD SIMON & SONS, LTD.
BASFORD, NOTTINGHAM
Also Makers of Automatic Weighing Machinery

FILTER PRESS CLOTHS

JOHN BRIGHT & BROTHERS, LTD.
ROCHDALE, ENGLAND.
FILTER PRESS CLOTH.
COTTON CANVAS.
HAIR AND COTTON BELTINGS FOR DRIVING & CONVEYING

FILTER PRESSES

S. H. JOHNSON & CO.
LIMITED.
CARPENTERS' ROAD,
STRATFORD,——E. 15.
FILTER PRESSES

IRON PYRITES

IVOR R. JONES
MINERAL MERCHANT, ETC.
PURPLE ORES
BURNT ORES
IRON PYRITES
ATLANTIC CHAMBERS, BRAZENNOSE STREET,
'Phone: 4558 Central.
'Grams: "Pyrites, Manchester."
MANCHESTER

SPRAYS

25,000,000 TONS of VITRIOL
Produced Annually with aid of
MONARCH SPRAYS

WATSON-MILLS
ACID SURFACE CONTACT SYSTEM
FOR INSIDE VITRIOL CHAMBERS
SAVES: CHAMBER SPACE AND NITRE

H. T. WATSON, 46, Fairfield Rd., WIDNES
Tel.: 313

STEEL DRUMS

TODD'S "AWLTOPLID" DRUM
The Steel Package with the full open top

Makers of ALL KINDS OF LIGHT STEEL
DRUMS & KEGS

TODD BROS.
Phone: 167 WIDNES Grams: "TODD"

VACUUM PUMPS

"Pulsometer"

"Vacuum" Symbol

VACUUM PUMPS

SAME HIGH EFFICIENCY OBTAINABLE WITH FACTORY OR LABORATORY SIZES

Write for List No. 1231

Pulsometer Engineering Co. Ltd.

11, Tothill Street, LONDON, S.W.1
Nine Elms Iron Works, READING

ERNEST HICKSON

Formerly of 38 Well Street, Bradford

Ings Lane, CASTLEFORD, Yorks

Has over 25 years' experience of the Aniline Dye Trade, and is well posted in all the Novelties of the day

ANILINE COLOURS

LACTIC ACID, NITRITE of SODA

DYES and other DYEWARES

AGENT FOR SCHIRP'S CARBONISING DRUMS

Telephone No. 140 **Telegrams: "ROSEINE," Castleford**

AT LAST ! ! !

BRITISH BALANCES

AT THE

COST OF FOREIGN

Repairs and Renovations

WRITE FOR QUOTATION—

J. W. HARRIS

(Formerly with L. OERTLING, Ltd.)

53, DEANSFIELD ROAD, LONDON, S.E.9

PYRONIUM: Opacifying Substitute for TIN OXIDE IN ENAMELS

Oxides of:— IRON, TIN, COPPER, COBALT, CHROME, MANGANESE, NICKEL, URANIUM, ANTIMONY, CADMIUM &c. SULPHIDE.

All kinds of Chemicals for Vitrifications.

PYRAMID CONES for Testing Temperatures

PURE KRAFT SACKS

3, 4, 5 and 6 Ply in ANY SIZE
to suit
ANY of your PRODUCTS

We are SPECIALISTS

KRAFT SACKS LTD., WELTON
MIDSOMER NORTON, SOM.

HOPKIN & WILLIAMS, LTD.

16 & 17 Cross St., Hatton Garden, London, E.C.1. *Works:* **Ilford, Essex**
Telegrams: "Cerium, Smith, London" **Telephone: Holborn 6884 & 6885**

The Leading British House for CHEMICAL REAGENTS Pure, Fine and Rare Chemicals.

Manufacturers of Guaranteed CHEMICAL REAGENTS for ANALYSIS and RESEARCH.

Made and supplied to standards and specifications described in the publication

"ANALYTICAL REAGENTS: STANDARDS AND TESTS"

Compiled by EDMUND WHITE, B.Sc. (Lond.), F.I.C.
Published by HOPKIN & WILLIAMS, LTD.
CLOTH BOUND. *INTERLEAVED.*
Price 1/6 post free from the Publishers.

DISTILLED WATER

Brown's Stills are perfectly automatic. Can be run night and day without attention. Patented in U.K. and Continental Countries.

Extraordinarily efficient and economical. Made for gas, steam, oil or coke fire heating.

Full particulars and prices free on application.

BROWN & SON (Alembic Works) Ltd.
Wedmore Street, Holloway, N.19

PREPAID CLASSIFIED ADVERTISEMENTS

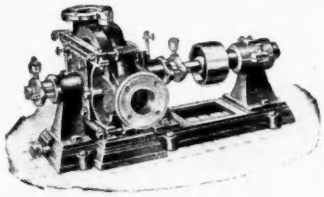
2d. per word, minimum 3/-; 3 insertions for price of 2. *Sales by Auction, etc., 8/- per inch, 4/6 per half inch*

THE CHEMICAL AGE, 154, Fleet Street, London, E.C.4 *Telephone: City 0244*

Please type; or write in block capitals.

HAUGHTON'S
ACID PUMPS
for
SULPHURIC ACID

23 PUMPS
SUPPLIED TO ONE FIRM FOR
ARTIFICIAL SILK



HAUGHTON'S PATENT METALLIC PACKING Co. Ltd.
30, ST. MARY-AT-HILL, LONDON, E.C.3
Telephone: Royal 1383

MIXING

FEATURES:
FREE REVOLVING HEAD
—
STIRRERS INSTANTLY REMOVED
—
INTER-CHANGEABLE PANS
—
BALL BEARINGS
—
FROM 2½ TO 40 GALLONS

ALSO:
GRINDING MACHINES
—
SIFTERS
—
MIXING MACHINES FOR ALL PURPOSES
—
EMULSIFIERS
—
MAGNETIC SEPARATORS

★ THE "AUTOSELL" MIXER ★
PATENT NO. 260745
FOR PASTES, MASSES, GUMS, SEMI-LIQUIDS, Etc.
In Acid-Resisting Metal, Ebonite, Etc.

W. ROWLANDSON & CO.
75N, MARK LANE, LONDON, E.C.3
TELEPHONE: ROYAL 3634

H. K. LEWIS & Co. Ltd.
SCIENTIFIC and TECHNICAL BOOKSELLERS

LARGE STOCK OF TEXTBOOKS AND RECENT LITERATURE IN ALL BRANCHES OF SCIENCE, THEORETICAL, TECHNICAL AND APPLIED

Prompt attention to Orders and Enquiries for Foreign Scientific and Technical Books.

All kinds of SCIENTIFIC and GENERAL STATIONERY kept in stock.

Second-hand Department - - 140 GOWER STREET
Catalogue on application. Telephone: MUSEUM 4031

Scientific and Technical Circulating Library
Hours: 9 a.m. to 6 p.m., Sats. to 1 p.m.

Annual Subscription:
Town or Country from ONE GUINEA

ALL THE LATEST WORKS OBTAINABLE WITHOUT DELAY

CATALOGUE of the Library, revised to December, 1927, containing classified Index of Subjects and Authors. Demy 8vo, price 15/- net (to subscribers 7/6 net).

BI-MONTHLY Lists of Additions sent post free on request.

136 Gower Street and 24 Gower Place
Telephone: MUSEUM 7756-7-8 LONDON, W.C.1

CARBONATE

THISTLE BRAND

AMMONIA

LUMP	PHARMACY
POWDER	BAKING
(free running)	INDUSTRIAL

SOLE MAKERS:
THE WESTERN CHEMICAL CO.
(PAISLEY) LTD.
SANDYFORD WORKS PAISLEY

The
LANCASTER
STEAM TRAPS

The most economical trap made. Will drain water at from 212° Fahr. upwards from any pressure of steam. Can be examined while working. The users of over 140,000 of the "LANCASTER" Steam Traps testify to their efficiency.

LANCASTER & TONGE LTD.
Pendleton **Manchester**
Telephone: PENDLETON 794 Telegrams: "PISTONS," Manchester

The
LIMMER & TRINIDAD LAKE ASPHALT CO. LTD.
HAVE
MOVED
TO
ARTILLERY HOUSE, ARTILLERY ROW, WESTMINSTER, S.W.1

J. M. COLLETT & CO., LTD.
GLOUCESTER ENGLAND
SULPHUROUS ACID
SULPHITES, BISULPHITES
AND METABISULPHITES
HIGHEST PURITY FOR USE WITH FOOD PRODUCTS
Export Agents: BRYCE, ROBARTS & Co., Ltd., 43-45, Great Tower Street, E.C.3

CONTRACTORS TO H.M. & FOREIGN GOVTS.
Established 1830.

Manufacturers and Proprietors of "INVICTA" Bituminous Materials for Road Construction

"Invicta" Decolourising Carbons

Wood and Animal Charcoal

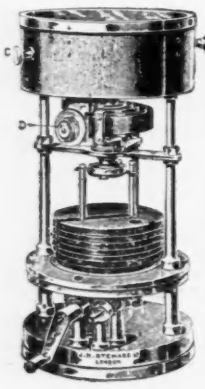
Manganese · Plumbago

Grinding of every description of Chemical and other materials, for the trade, with improved Mills.

THOMAS HILL-JONES, Ltd.,
Manufacturing Chemists
INVICTA WORKS, BOW COMMON LANE, E.3
AND AT
MEESON'S WHARF, BOW BRIDGE, E.
'Phone: East 3632, 3633 Telegrams: "HILLJONES, POP, LONDON."

For ascertaining easily and accurately the Lubricating Value of Oils,

also the Oiliness, or Efficiency, by determining the Static Friction between any desired Metals.



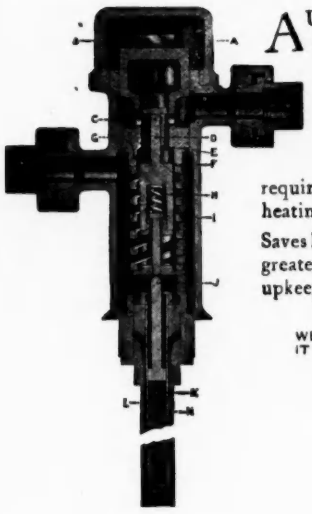
THE DEELEY
FRICTION MACHINE
(PATENT)

Descriptive Pamphlet of the Machine, stating the principles upon which it is based, together with directions for testing Oils, will be forwarded on application to the Sole Manufacturers:

J. H. STEWARD, Ltd.
Scientific Instrument Makers.
ESTABLISHED 1852
406 & 457 STRAND, LONDON, W.C.2

The "HORNE"

Thermostatic Valve



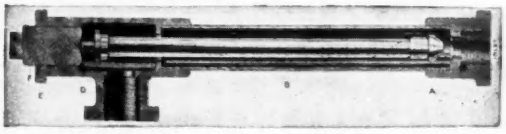
AUTOMATICALLY controls the steam supply to calorifiers of any design.

Can be fitted to appliances where a steady temperature is required irrespective of the heating medium.

Saves labour and fuel, ensures greater efficiency and the upkeep is low.

WRITE FOR BOOKLET
IT TELLS YOU HOW

Steam Trap



Will cope with large amounts of condensation. Easy to fit. Will work in any position.
EFFICIENT · SIMPLE · DURABLE

TRY THESE SPECIALITIES FREE
AND WATCH THE SAVING

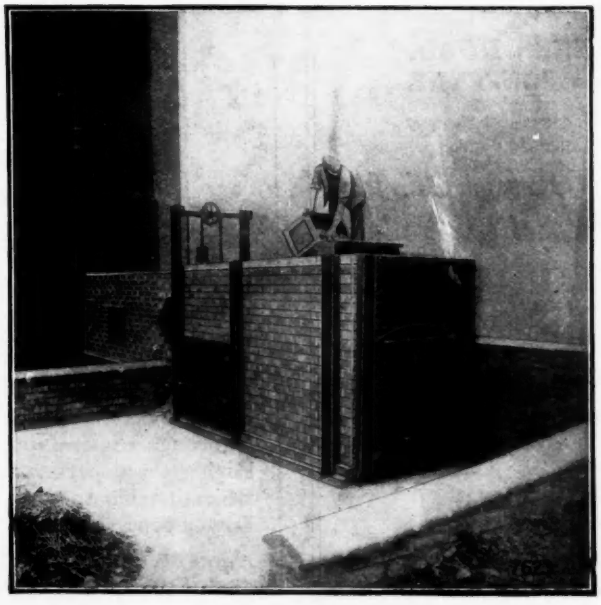
FIRST ORDERS ON APPROVAL

HORNE ENGINEERING CO.
35 - PITT STREET - GLASGOW

INCINERATORS FOR BURNING REFUSE

THE BEST WAY TO DEAL WITH REFUSE IS TO BURN IT.

MANLOVE'S INCINERATORS ARE THE MOST SATISFACTORY FOR THIS PURPOSE.



VARIOUS TYPES AND OF GRATE AREAS TO SUIT CONDITIONS.

SUPPLIED WITH OR WITHOUT FAN.

MANLOVE, ALLIOTT & CO., LTD.
ENGINEERS : NOTTINGHAM

Norit Purit Esbit Carboraffin

Activated Carbons

PRODUCED IN GRADES TO SUIT EVERY REQUIREMENT

World Wide Reputation for Efficiency & Economy

Correspondence invited on all technical difficulties.
Our well equipped laboratories and extensive :: :: practical experience at your disposal :: ::

UNITED NORIT SALES OFFICE
AMSTERDAM, C.

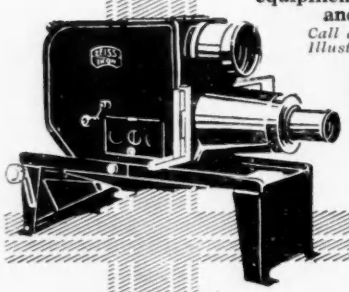
✣

For full particulars, samples, etc.
Write to
SOLE BRITISH REPRESENTATIVES:

HALLER & PHILLIPS Ltd.

Telephone: LONDON WALL 4456-7. | **69 Bishopsgate LONDON E.C.2** | Telegrams: "HALOID, LONDON."

Zeiss Ikon Epidiascope



By means of this new Epidiascope, greatly enlarged and well-illuminated pictures of maps, photographs, drawings, etc., can be projected in the colours of the originals. For all branches of educational work the Epidiascope is a wonderfully convenient piece of apparatus and is now considered an indispensable equipment in many schools and laboratories.

Call and see a demonstration. Illustrated Booklet Post Free.

SANDS HUNTER & CO., LTD.
37 BEDFORD ST. W.C.2

CORTIN & CORKING LTD.

Chemical Plant Manufacturers

ST. LAWRENCE ROAD, NEWCASTLE-UPON-TYNE

TELE { PHONE: 551 CENTRAL / GRAMS: CORTIN, NEWCASTLE-UPON-TYNE

Acid Valves, Taps, Pumps, &c., for the Chemical and Allied Trades.

ALSO COMPLETE LEAD BURNING APPARATUS

No. 42. Straight Through Non-Return Acid Valve.

CHLORETHOL

SOLVES YOUR SCOURING PROBLEM

Cleaner scour
High boiling point
Level dyeing first time
Obtains excellent results from raw wool to piece
Removes fatty matter quickly
Ensures better handle on all piece goods
Thorough—Safe—Non-inflammable
High solvent percentage
Objectionable smells removed
Lower scouring costs. Less soap required.

Agents : **F. BURNETT & COMPANY**
8, Princess Street, HUDDERSFIELD

Makers :

BREAKS BROS.
Bolton Woods, BRADFORD

Telephone: 2837 **Telegrams: CARMINE**

CLASSIFIED ADVERTISEMENTS

All Advertisements must in every case be PREPAID, and must reach the Office,
Bouverie House, 154, Fleet Street, London, E.C.4,
first post Thursday, for publication in the same week's issue.

Agencies, Businesses for Disposal, Businesses Wanted, Machinery, Plant, Materials for Sale, Machinery, Plant, Materials Wanted, Miscellaneous Sales, Miscellaneous Wants, Partnerships, Patents, Road Transport, Situations Vacant: **2d.** per word; Minimum **3/-**; **3** Insertions price of **2**.

Situations Wanted: **1d.** per word; Minimum **1/6**; **3** Insertions price of **2**.

Public Appointments: **4/-** per inch.

Contracts and Tenders, Legal Notices, Sales by Auction, Semi-displayed: **4/6** per Half-inch per Insertion; **8/-** per Inch per Insertion. Replies can be received "Box , Office of this Journal," in which case our address is included in the cost of advertisement, and charged as six words.

BRITISH ASSOCIATION OF CHEMISTS

Unemployment Insurance.
Over £5,000 paid.
Legal Aid. Income Tax Advice.
Appointments Bureau.

Write for particulars to:—
GENERAL SECRETARY,
B.A.C.,
"EMPIRE HOUSE,"
175, PICCADILLY,
LONDON, W.1

SITUATIONS WANTED

CHEMICAL Graduate, 28, laboratory, plant and office experience, desires progressive position. Moderate salary.—Box 1172, THE CHEMICAL AGE, Bouverie House, 154, Fleet Street, E.C.4.

ENGINEER (32), 10 years' experience of refrigeration. Good organiser, excellent draughtsman. Knowledge of press tools and sheet metal work. Two years Sales Engineer. Fifteen months at sea, Australian trade. Desires progressive position in works or on commercial side.—Box No. 1174, THE CHEMICAL AGE, Bouverie House, 154, Fleet Street, London, E.C.4.

MACHINERY, PLANT, &c. FOR SALE

HYDRAULIC PRESSES AND PUMPS. Large stock in London. Prices quoted for adapting and erecting.—THOMPSON AND SON, Maria Street, Millwall.

MACHINERY, PLANT, &c., FOR SALE—*continued*

TWO ROLLER CRUSHING MILLS having two independent pairs of 30 in. long by 9 in. dia. finely fluted chilled rolls, differential helical gears, self-oiling bearings and roller feeds. Suitable for crushing coal or similar material to dust at large capacity, with low power, speed and space. Price to clear, £25 each.

SEVERAL CENTRIFUGAL AND REEL FLOUR OR POWDER SIFTER SEPARATORS, all sizes, from 40 in. by 16 in. reels up to 13 ft. by 30 in. cylinders, in wooden frames; overhauled like new, at prices from £15 each.

ELEVATORS, WORM SCREW AND BAND CONVEYORS, overhauled. Second-hand; made up to customers' requirements at a fraction of new cost.

Nearly new No. 3½ CARTER'S DISINTEGRATOR, with ring bearings; £40.

Several Dead Weight type WEIGHING MACHINES for sacks.

BULK MIXERS for hand and power, for thorough blending of any kind of granular or powdered material, in varying grades or weights.

For fuller particulars apply to J. BOOTH AND SON, Crushing and Grinding Machinery Manufacturers, Congleton, Cheshire.

MISCELLANEOUS SALES

CARRAGHEEN Moss.—Stocks always on hand in English warehouses.—Samples and particulars from J. W. CUMMING AND SON, Clonliffe, Dublin. Telegrams: "Cumming, Dublin."

CYMRIC TRADING COMPANY, LTD.
Cymric House, Adelaide Street,
CARDIFF.

Enquiries solicited for:—
Rails, all sections.
Sleepers, 9×10×5, and tram sleepers.
Works Wagons for all purposes.
CHEAP TO CLEAR.
SPECIAL RATES TO DEVON & CORNWALL.

MISCELLANEOUS SALES—*continued*

CREAM OF TARTAR B.P. 1914.—15 tons for immediate shipment. Enquiries or offers invited.—Box No. 1177, THE CHEMICAL AGE, Bouverie House, 154, Fleet Street, London, E.C.4.

CHARCOAL, ANIMAL and VEGETABLE horticultural, burning, filtering, disinfecting, medicinal, insulating; also lumps ground and granulated; established 1830; contractors to H.M. Government.—THOS. HILL-JONES, LTD., "Invicta" Mills, Bow Common Lane, London, E. Telegrams: "Hill Jones, Pop. London." Telephone: 3633 East.

CHEAPER than a wooden cask.—Several hundred heavy welded Steel Cylinders. Two sizes—6 cwt. and 10 cwt.

Suitable for export or home trade; available for immediate delivery.

Prices upon application. VICTOR BLAGDEN & CO., LTD., Coronation House, 4, Lloyd's Avenue, London, E.C.3.

RAILWAY TANK WAGONS for disposal. Cylindrical, 10, 14, and 20-tonners. Specially suitable for Inflammable Liquids, Oils and Acids. Enquiries invited.—BROTHERTON AND CO., LTD., Leeds.

CLASSIFIED ADVERTISEMENTS

MISCELLANEOUS SALES—*continued.*

BICARBONATE of Ammonia (Balloon Brand), for Industrial purposes, £18 per ton, in 2 cwt. or 5 cwt. Casks.—BROTHERTON AND CO., LTD., City Chambers, Leeds.

FORTY 1½ in. CAST-IRON CHEMICAL VALVES, majority with UNDRILLED FLANGES, not previously been in use; weight 35-40 lb. each.

Price 10s. 9d. each, delivered, carriage paid, in lots of four.

HUBERT JONES,
KING STREET WAREHOUSES.
BURY, LANCS.

GLASS-LINED Steel Circular Tanks, domed ends, 1,650 gallons. Hydraulic Presses, 200 tons. Platens, 15 in. by 15 in. Portable Electric Friction Hoists, 10 cwt. Vacuum Pump, three stage.—D., 41, Latimer Avenue, East Ham, E.

TARTARIC ACID B.P. 1914.—20 tons for immediate shipment. For price and particulars apply Box No. 1175, THE CHEMICAL AGE, Bouverie House, 154, Fleet Street, London, E.C.4.

MISCELLANEOUS WANTS

EDWARD RUSHTON, SON AND KENYON, Auctioneers, Valuers and Fire Loss Assessors of Mills, Works, and Machinery of all kinds, 13, Norfolk Street, Manchester.

Tel. Nos. 8895 and 8896 City. (Estab. 1855. Telegrams: "Rushtons, Auctioneers, Manchester." And 21, Richmond Terrace, Blackburn.

GRINDING of every description of chemical and other materials for the trade with improved mills.—THOS. HILL-JONES, LTD., "Invicta" Mills, Bow Common Lane, London, E. Telegrams: "Hill Jones, Pop. London." Telephone: 3633 East.

TUITION.

SUCCESSFUL TUITION.—Matriculation and Similar Examinations.—DAVIES AND LAING, 15, Lancaster Street, W.2. Padd. 7662.

PATENTS AND TRADE MARKS

KING'S PATENT AGENCY, LTD. (B. T. King, Registered Patent Agent, G.B., U.S., and Can.), 146A, Queen Victoria Street, London, E.C.4. Advice Handbook and Cons. free; 43 years' ref. 'Phone: Central 0682

PATENTS obtained, trade marks and designs registered, at home and abroad.—GEE AND CO., Patent and Trade Marks Agents. (Patent and Trade Mark advisers to THE CHEMICAL AGE), 51-52, Chancery Lane, London, W.C.2. Telephone: Holborn 1525. Established 1905.

THE Proprietors of British Patent No. 164 627 are prepared to sell the patent or to license British Manufacturers to work thereunder. It relates to lead chambers for the manufacture of sulphuric acid.—Address, BOULT, WADE AND TENNANT, 112, Hatton Garden, London, E.C.1.

JUST PUBLISHED

A CONDENSED OUTLINE OF

MODERN PHYSICAL CHEMISTRY

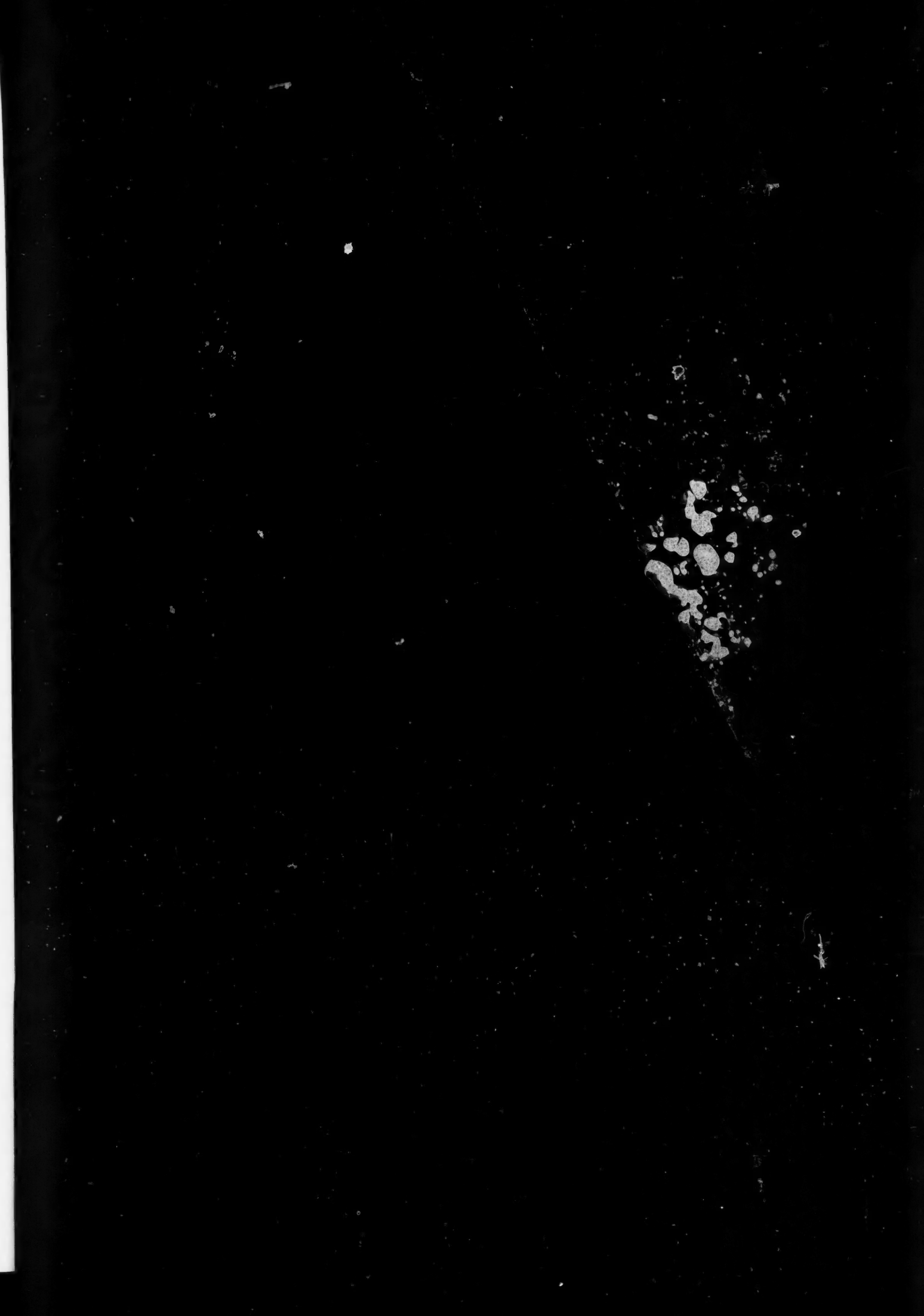
by

Frederick Hurn Constable,
M.A., D.Sc., Ph.D., F.I.C., F.Inst.P., F.R.A.S.
Fellow of St. John's College, Cambridge, Director of the Research Laboratories of Radiovisor Parent Ltd.

Price 10/6 Net.

Price 10/6 Net.

This summarised account of physical chemistry has been written for candidates who are reading chemistry up to the final stage of their university course, and are conversant with elementary mathematical methods. It may also be used with advantage by those who are taking open scholarships at Oxford and Cambridge, and by masters giving advanced courses in public and secondary schools. The whole ground is covered, and care has been taken to include all fully established recent developments, without minimising the importance of the older foundations on which the science rests.

Through any Bookseller or direct from the Publisher

ERNEST BENN Ltd., Bouverie House, 154, Fleet Street, E.C.4